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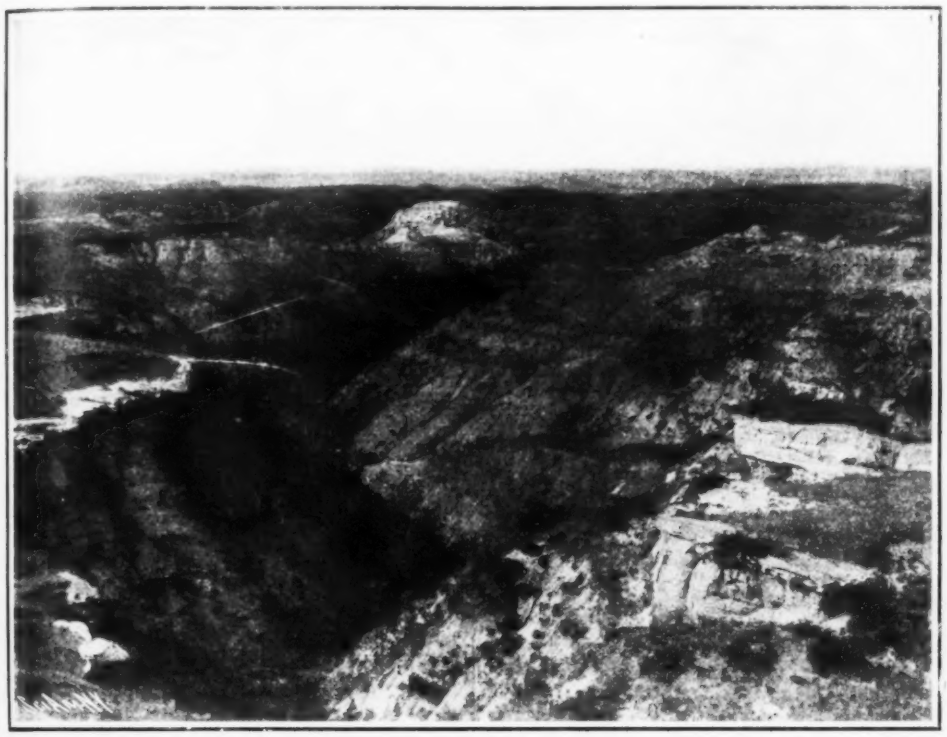
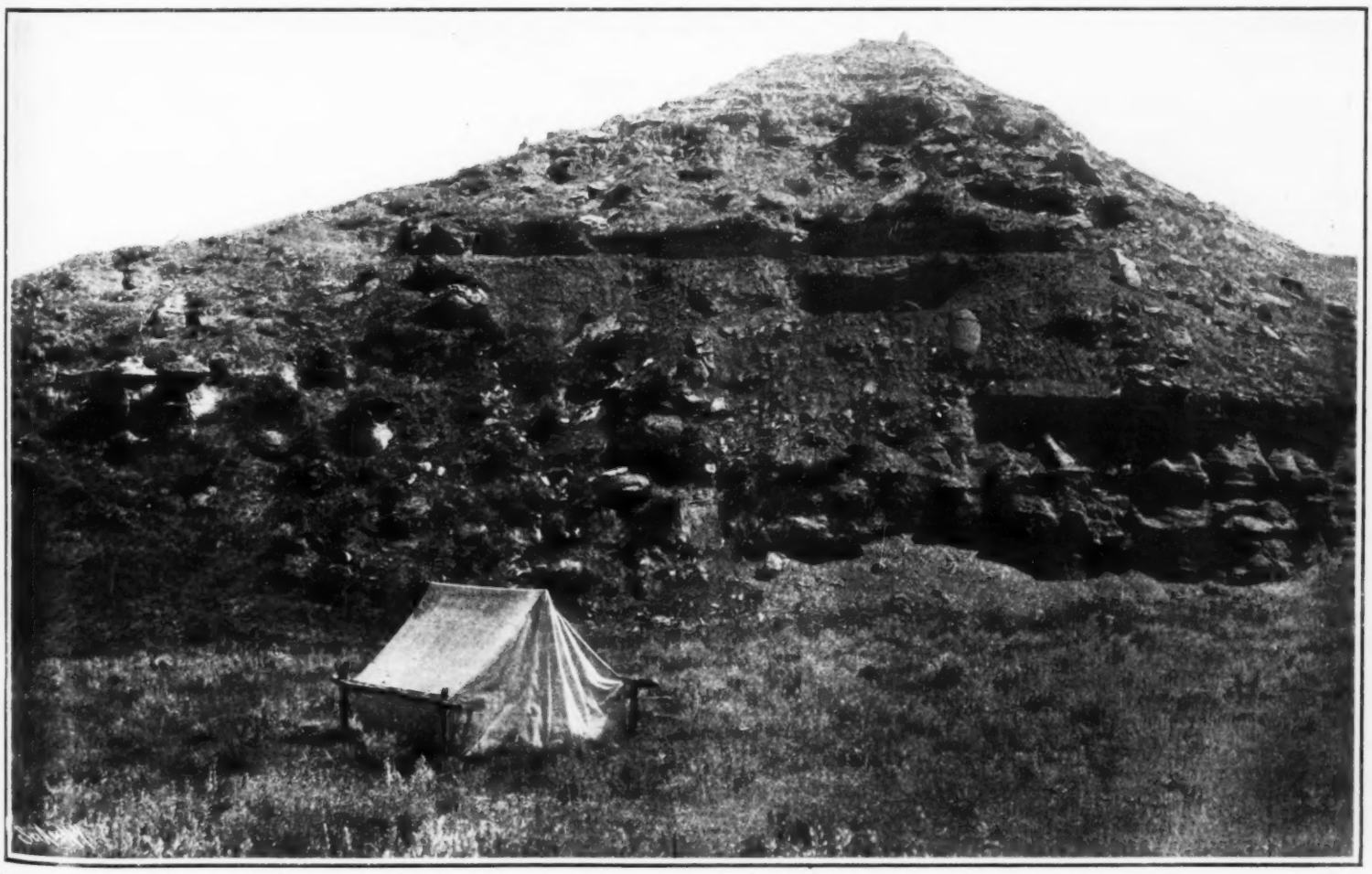


THE BAD LANDS OF THE HELL CREEK REGION. ONE OF THE MOST RUGGED AND PICTURESQUE BAD LANDS OF THE WEST.

DIGGING OUT THE TYRANNOSAURUS BONES.

TRANSPORTING THE LARGEST BLOCK, WEIGHING 4,100 POUNDS, TO THE RAILROAD.



THE TYRANNOSAURUS QUARRY ON THE OLD MAX SIBER RANCH, HELL CREEK, MONTANA, SHOWING THE CUTS MADE IN THE HILLSIDE.

MINING FOR FOSSILS.

MINING FOR FOSSILS.*

WHILE the vast prehistoric period characterized by the domination of great and small animals like, and yet exceedingly unlike, those with which we are acquainted is tremendously interesting, not only to the student of paleontology, but to the layman as well, that prior age, older and greater, wherein the reptilian order flourished is still more fascinating to investigate. As the major part of the creatures inhabiting the earth to-day are mammals, we feel more or less familiar with that order. With reptiles in general, however, the case is different, for the existent representatives have so hopelessly degenerated, or are so totally different from their Cretaceous, Jurassic, or Triassic ancestors, that the contemplation of many of these giant creatures arouses in the mature mind that same wonder with which a child receives its first fairy tale. And to the uninitiated the science of paleontology seems almost to deal with magic, a magic through the exercise of which we are enabled to gather from the study of a few fossilized bones not only the probable size, form, characterization, and appearance, but the general habits and methods of life as well, of organisms that existed not thousands, but millions of years ago.

The advancement of paleontology in this country, and in general, is due in many particulars to the American Museum of Natural History of New York city. The readers of the SCIENTIFIC AMERICAN are familiar with one of these, the great Brontosaurus restoration, which was executed by the Department of Paleontology of that institution, and which at present is the center point of interest in the great Dinosaur Hall. Within a few months there will be added to the collection another mounted specimen of the giant saurians, which while inferior in size is undoubtedly not less remarkable in its characteristics than the huge "thunder saurian" already on exhibition. This is one of the great carnivorous dinosaurs of the Upper Cretaceous or Laramie age, and as it greatly exceeds in size any known carnivorous land animal, Prof. Henry F. Osborn, curator of the Department of Vertebrate Paleontology of the Museum, proposed to make this a type of a new genus, Tyrannosaurus. Thus the public has within recent weeks become quite familiar through the newspapers and periodicals with *Tyrannosaurus Rex*, or as the reporter delights to put it, King of Tyrant Saurians. It is not strictly correct to designate this fossil discovery as quite recent, for the first bones found were located during the summer of 1902. In 1901 Dr. Hornaday, director of the New York Zoological Park, while on a hunting and photographing trip through certain bad lands of Montana, picked up a fossil which was later found to be a Triceratops horn. This was shown to Prof. Osborn, and after a study of the photographs of the characteristic bad lands where it was found, the importance of the discovery was deemed sufficient to warrant the sending of an expedition to this region. Accordingly, the American Museum dispatched a party to this part of Montana in the summer of 1902 under the leadership of Mr. Barnum Brown. The quarry was located about 130 miles northwest of Miles City in Dawson County, on the old Max Siber ranch, and from a small stream in the vicinity it took the name of Hell Creek Quarry. The region comprises one of the most rugged and picturesque bad lands of the West, according to Mr. Brown, whose long experience in work of this character makes him well qualified to judge. The accompanying engraving, from a photograph of the Hell Creek region, gives an excellent idea of the general character of the country in which fossils are commonly found in the United States. While a fossil-hunting expedition is often attended by weeks and months of painstaking but disappointing labor, the instance in question was quite the reverse, for within a few hours the quarry had been definitely located, and after nearly eight millions of years of obscurity, *Tyrannosaurus Rex* was about to be haled forth into the light of scientific investigation.

In September of 1902 all the bones in sight were removed from the sandstone hill whereon the quarry is situated, and it was then believed that all the fossils at that locality had been recovered. At present these, comparatively small in number, but formidable in size, are already on exhibition in Dinosaur Hall, and they include six great vertebræ, small humerus—believed to belong to this animal—portions of the skull and jaws, and the ilium, pubis, and ischium. The last three are the pelvic bones, which are separate in reptiles, while in the order Dinosauria the pubis and ischium were the two great developed, downwardly-projecting members, which, supplied with pads of cartilage, were used to rest upon in a sitting position.

During the past summer of 1905, a second expedition to the region of Hell Creek under Mr. Brown, while not sent ostensibly for that purpose, again made a number of excavations where the first Tyrannosaurus bones had been found, and at the very bottom of a four-foot cut a number of additional bones was discovered, including a large hip-bone from the same specimen. This success was immediately followed by the institution of further excavation, and a large cut, thirty feet long, thirty feet wide, and twenty-five feet deep, shown on the hillside in one of the illustrations, produced many other portions of the skeleton. The operations entailed many weeks of labor in the field, and promised many more for the laboratory, for the matrix containing the bones, which were all on one level, is a sandstone almost as hard as granite, involving the use of a diamond-saw in the removal of the concretion, at the Museum. The first nine feet of the cut were plowed and scraped out with the help of horses, the remainder was removed by careful blasting. We can easily understand the extreme delicacy with which the latter operation must be performed when we take into consideration the brittle nature of the fossils, the hardness of the surrounding concretion, and the frequently involved positions of some of the bones. In fact, it was impossible to remove many of the fossils individually, so the surrounding matrix was cut out in a block, leaving the segregation of the bone to the laboratory force. The largest lot, shown in the photograph during removal, weighed 4,100 pounds, and it required fourteen days' labor to transport the same to the railway.

The discovery included so many representative portions of the skeleton of this great flesh-eating dinosaur, that its general appearance can be described with reasonable accuracy. Tyrannosaurus, when in the erect position, which in all probability he habitually assumed, measured about thirty-nine feet in length, and carried his head at a height of some nineteen feet above the ground. Some doubt still exists about the possible size of the forearm. In the first collection made in 1902 there were a small humerus and a small femur associated with the Tryannosaurus bones. The humerus was supposed to belong to Tryannosaurus, and the latter was restored, theoretically, with a short forearm like the Jurassic carnivores, but in the collection of this year there is a large bone thought to be a humerus, and in this case the entire character of the animal would be changed. The whole matter can be cleared only by freeing these new bones from the inclosing rock. He was practically a biped, with an agile, bird-like manner of locomotion. The huge feet, about four feet long and three feet wide, also show bird-like characteristics, with three enormous toes projecting forward, and one extending backward. The toes of all four limbs were provided with great tearing claws. Enough skull bones were found to determine all of the characteristics of the head, which was far larger and contained a greater brain than that of the sluggish Brontosaurus, and was provided with great, sharp-edged serrated teeth, some of which were six inches long. Supplied by nature with such weapons, we can easily imagine that Tryannosaurus made life miserable for some of his more inoffensive neighbors.

It is almost impossible to estimate the value of this find to the science of paleontology. It has already caused the reclassification of a number of the great denizens of the earth toward the end of the age of reptiles, among them the type Dynamosaurus, another carnivorous dinosaur, and the somewhat more primitive genus Albertosaurus, hitherto included in the type Driptosaurus. The extreme rarity of fossils of this kind adds greatly to their value, a rarity undoubtedly due to the fact that the creatures were essentially land animals, that they were born, lived, and died in the open, where their remains were speedily disintegrated and destroyed. In the case of amphibious dinosaurs, on the other hand, the bodies usually settled to the bottom of the waters wherein the animals existed, and were gradually covered over in the formation of the sedimentary rocks, in which we find these fossils to-day. And so the preservation of individuals of the land species only occurred when the body accidentally became submerged in one of the waters of the region in which they lived. In three years' work carried on by the American Museum in the Cretaceous formations, parts of only three skeletons of this kind have come to light, one of these, an allied species of the same geological age, being found in Wyoming. From the traces of palms, rushes, and ferns, which are often found together with the bones of the Cretaceous period, the conclusion has been drawn that this region then possessed a sub-tropical climate, not unlike that of the West Indies of to-day. The region also included the great seas and lakes of salt or brackish water, the sedimentary remains of which are the bad lands of our age, the greatest fossil graveyard of the world.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT

ALLOY OF THORIUM.

FOLLOWING his researches upon the preparation of silicide of thorium ($Th\ Si_2$) O. Hönigschmid was led to seek whether he could not form an alloy of thorium and aluminium under the conditions of his experiments. Microscopic study of the masses obtained by the action of aluminium on the mixture of fluosilicate of potassium and of double fluoride of potassium and thorium showed, besides the quadratic plates of silicide, a series of long hexagonal prismatic crystals in the form of fine needles. Direct trials allowed him to prepare these crystals in greater quantity, either by the direct combination of aluminium and thorium *in vacuo* at a high heat or by reduction, using aluminium to reduce the double fluoride of thorium and potassium. We also obtain them by the reduction of thorium oxide by means of aluminium in the electric furnace. The crystals which are thus obtained, when separated from aluminium by the action of potash, show a metallic luster and have the color of aluminium. They will burn in fluorine or chlorine gas, and are attacked at a red heat by bromine and iodine without glowing. Although unchangeable in air, they oxidize at a red heat and burn with a bright glow. They are attacked by all the mineral acids. Alkaline solutions have no action upon them, but they are oxidized with incandescence by potash, soda, and alkaline carbonates in fusion. To analyze the crystals they are dissolved in hydrochloric acid, and the thorium is precipitated by oxalic acid and weighed in the state of oxide. The aluminium is thrown down from the filtered solution by ammonia after the destruction of the oxalic acid. The results of analysis show that the new compound corresponds to the formula $Th\ Al_2$.

VALUABLE ALLOYS.

SHEET BRASS. (FOR SHEET AND WIRE.)

IN the preparation of brass for the manufacture of wire, an especially pure quality of copper must be used; without this, all efforts to produce a suitable quality of brass will be in vain. That pure copper is indispensable to the manufacture of good, ductile brass, may be seen from the great difference in the composition of the various kinds, all of which answer their purpose, but contain widely-varying quantities of copper and zinc. The following table shows the composition of some excellent qualities of brass suitable for making sheet and wire:

Brass Sheet— Source.	Copper. Per ct.	Zinc. Per ct.	Lead. Per ct.	Tin. Per ct.
Jemappes	64.6	33.7	1.4	0.2
Stolberg	64.8	32.8	2.0	0.4
Romilly	70.1	29.26	0.38	0.17
Rosthorn (Vienna)	68.1	31.9	....	....
Rosthorn (Vienna)	71.5	28.5	....	....
Rosthorn (Vienna)	71.1	27.6	1.3	....
Iserlohn & Romilly	70.1	29.9	....	....
Lüdenscheid	72.73	27.27	....	....
(Brittle)	63.66	33.02	2.52	....
Hegermühl	70.16	27.45	0.79	0.20
Oker	68.98	29.54	0.97	....
Brass Wire—				
England	70.29	29.26	0.28	0.17
Augsburg	71.89	27.63	0.85	....
Neustadt	70.16	27.45	0.2	0.79
Neustadt	71.36	28.15	....	....
Neustadt	71.5	28.5	....	....
Neustadt	71.0	27.6	....	....
(Good quality)	65.4	34.6	....	....
(Brittle)	65.5	32.4	2.1	....
For wire and sheet	67	32	0.5	6.5

As the above figures show, the percentage of zinc in the different kinds of brass lies between 27 and 34. Recently, alloys containing a somewhat larger quantity of zinc have been used, it having been found that the toughness and ductility of the brass are increased thereby, without injury to its tenacity. Alloys containing up to 37 per cent of zinc possess a high degree of ductility in the cold, and are well adapted for wire and sheet.

MOSAIC GOLD, CHRYSORIN, HAMILTON'S METAL.

The above names are applied to an alloy composed—with slight deviations—of 100 parts of copper and 50 to 55 of zinc. It has a very beautiful color, closely resembling that of gold, and is distinguished by a very fine grain, which makes it especially suitable for the manufacture of castings which are afterward to be gilded.

The best method of obtaining a thoroughly homogeneous mixture of the two metals is to first put into the crucible one-half of the zinc to be used, place the copper upon it, and fuse the mixture under a cover of borax at as low a temperature as possible. Have ready the other half of the zinc, cut into small pieces, and heated almost to melting, and when the contents of the crucible are liquid throw it in, a small portion at a time, stirring constantly to effect as intimate a mixture of the metals as possible.

FRENCH CAST BRASS FOR FINE CASTINGS.

We are familiar with various articles of bronze, so called, statuettes, clock-cases, etc., made in France, where this industry has attained great perfection and extensive proportions. The material, however, is not, in most cases, genuine bronze, but fine cast brass. In the following table is given the composition of a few mixtures of metals most frequently used by French manufacturers:

	Copper.	Zinc.	Tin.	Lead.
I.	63.70	33.55	2.50	0.25
II.	64.45	32.44	0.25	2.86
III.	70.90	24.05	2.00	3.05
IV.	72.43	22.75	1.87	2.95

Their special advantage is that they can be readily cast, worked with file and chisel, and easily gilded.

BRISTOL BRASS (PRINCE'S METAL).

This alloy, which possesses properties similar to those of the above-mentioned varieties of French brass, is prepared in the following proportions:

	I.	II.	III.
Copper	75.7	67.2	60.8
Zinc	24.3	32.8	39.2

As regards the production of this and similar alloys, the remarks made with reference to Hamilton's metal are equally applicable. Particular care is required to prevent the zinc from evaporating during the fusing, and to this purpose it is customary to put only half of it into the first melting, and to add the remainder when the first mass is liquid.

MALLEABLE BRASS (YELLOW METAL, MUNTZ METAL).

This metal is less affected by sea water than pure copper, and was formerly much used for ship sheathing, and for making nails and rivets which were to come in contact with sea water. At the present day it has lost much of its importance, since all the larger ships are made of iron. It is usually composed of copper, 60 to 62 parts, and zinc, 40 to 38 parts.

Yellow metal, or Muntz metal (so called after its inventor) is prepared with certain precautions, di-

rected toward obtaining as fine a grain as possible, experience having shown that only a fine-grained alloy of uniform density can resist the action of the sea water evenly. A metal of uneven density will wear in holes. To obtain as uniform a grain as possible, small samples taken from the fused mass are cooled quickly and examined as to fracture. If they do not show the desired uniform grain, some zinc is added to the mass. After it has permeated the whole mass, a fresh sample is taken and tested, this being continued until the desired result is reached. It is scarcely necessary to remark that considerable experience is required to tell the correct composition of the alloy from the fracture. The mass is finally poured into molds and rolled cold. Malleable brass can be worked warm, like iron, being ductile in heat, a valuable quality.

MACHT'S YELLOW METAL.

This alloy consists of 33 parts of copper and 25 of zinc. It has a dark golden yellow color, great tenacity, and can be forged at a red heat, properties which make it especially suitable for fine castings.

BOBIERRE'S METAL.

The alloy called Bobierre's metal, consisting of 66 parts of copper and 34 of zinc, is said to be especially suitable for ship sheathing.

Experiments with malleable brass show that all alloys containing up to 58.33 per cent of copper and up to 41.67 per cent of zinc are malleable. There is in addition a second group of such alloys, with 61.54 per cent of copper and 38.46 of zinc, which are also malleable in heat.

The preparation of these alloys requires considerable experience, and is best accomplished by melting the metals together in the usual manner, and heating the fused mass as strongly as possible. It must be covered with a layer of charcoal dust to prevent oxidation of the zinc. The mass becomes thinly fluid, and an intimate mixture of the constituents is effected. Small pieces of the same alloy are thrown into the liquid mass until it no longer shows a reflecting surface, when it is cast into ingots in iron molds. The ingots are plunged into water while still red hot, and acquire by this treatment a very high degree of ductility. The alloy, properly prepared, has a fibrous fracture and a reddish yellow color.

AICH'S METAL.

Aich's metal, named after its inventor, is a variety of brass with an admixture of iron, which gives it a considerable degree of tenacity. It is especially adapted to purposes which require a hard and at the same time tenacious metal.

Analyses of the various kinds of this metal show considerable variation in the proportions of the metals used in preparing it. Even the amount of iron, to which the hardening effect must be attributed, may vary within wide limits without materially modifying the tenacity which is the essential characteristic of this alloy.

The best variety of Aich's metal consists of copper 60 parts, zinc 38.2, iron 1.8. The predominating quality of this alloy is its hardness, which is claimed to be not inferior to that of certain kinds of steel. It has a beautiful golden yellow color, and is said not to oxidize easily, a valuable property for articles exposed to the action of air and water.

Another Aich's metal, of excellent quality, is composed of copper 60.2 parts, zinc 38.2, iron 1.6. The permissible variations in the content of iron are from 0.4 to 3 per cent.

STERRO-METAL.

The alloy called sterro-metal may properly be considered in connection with Aich's metal, since its constituents are the same, and its properties very similar. The principal difference between the two metals is that sterro-metal contains a much larger amount of iron. The composition of this alloy, which is sure to have an important part in the future development of the metal industry, varies considerably with different manufacturers. Two varieties of excellent quality are the product of the Rosthorn factory, in Lower Austria—copper 55.33 parts, zinc 41.80, iron 4.66; and the English sterro-metal (Gedge's alloy for ship sheathing), copper 60 parts, zinc 38.125, iron 1.5.

The great value of this alloy lies in its strength, which is equaled only by that of the best steel. As an illustration of this, a wrought-iron pipe broke with a pressure of 267 atmospheres, while a similar pipe of sterro-metal withstood the enormous pressure of 763 atmospheres without cracking. Besides its remarkable strength, it possesses a high degree of elasticity, and is therefore particularly suitable for purposes which require the combination of these two qualities, such as the construction of hydraulic cylinders. It is well known that these cylinders, at a certain pressure, begin to sweat, that is, the interior pressure is so great that the water permeates through the pores of the steel. With a sterro-metal cylinder, the pressure can be considerably increased without any moisture being perceptible on the outside of the cylinder.

Sterro-metal can be made even more hard and dense, if required for special purposes, but this is effected rather by mechanical manipulation than by any change in the chemical composition. If rolled or hammered in heat, its strength is increased, and it acquires, in addition, an exceedingly high degree of tenacity. Special care must be taken, however, in hammering not to overheat the metal, as in this case it would become brittle and might crack under the hammer.

Sterro-metal is especially suitable for all the purposes for which the so-called red metal has been in the past almost exclusively used. Axle bearings, for example, made of sterro-metal, have such excellent qualities, that many machine factories are now using this material entirely for the purpose.

DELTA METAL.

An alloy widely used for making parts of machinery, and also for artistic purposes, is the so-called Delta metal. This is a variety of brass hardened with iron; some manufacturers add small quantities of tin and lead, also, in some cases, nickel. The following analyses of Delta metal (from the factory at Düsseldorf) will show its usual composition:

	I.	II.	III.	IV.	V.
Copper	55.94	55.80	55.82	54.22	58.65
Zinc	41.61	40.07	41.41	42.25	38.95
Lead	0.72	1.82	0.76	1.10	0.67
Iron	0.87	1.28	0.86	0.99	1.62
Manganese .	0.81	0.96	1.38	1.09	...
Nickel	Slight traces	Slight traces	0.06	0.16	0.11
Phosphorus..	0.013	0.011	Slight traces	0.02	...

I. is cast, II. hammered, III. rolled, and IV. hot-stamped metal. Delta metal is produced by heating zinc very strongly in crucibles (to above 900 deg. C). and adding ferro-manganese or "spiegeleisen," producing an alloy of 95 per cent zinc and 5 per cent of iron. Copper or brass and a very small amount of copper phosphate are also added.

TOBIN BRONZE.

This alloy is very similar in composition and properties to Delta metal. Some analyses will be given.

	I.	II.	III.	IV.
Copper	61.203	59.00	61.20	82.67
Zinc	27.440	38.40	37.14	3.23
Tin	0.906	2.16	0.90	12.40
Iron	0.180	0.11	0.18	0.10
Lead	0.359	0.31	0.35	2.14
Silver	....	....	....	0.07
Phosphorus	....	....	....	0.005

The alloy marked IV. is called in commerce deoxidized bronze.

ALUMINIUM BRASS.

A small addition of aluminium to brass (1.5 to 8 per cent) greatly increases its hardness and elasticity, and this alloy is also easily worked for any purpose. Brass containing 8 per cent of aluminium has the valuable property of being but slightly affected by acids or gases. A larger percentage of aluminium makes the brass brittle. It is to be noted that aluminium brass decreases very materially in volume in casting, and the casts must be cooled slowly, or they will be brittle.

It is an alloy easily made, and its low price, combined with its excellent qualities, would seem to make it in many cases an advantageous substitute for the expensive phosphorus bronze.

MANNHEIM GOLD OR SIMILOR.

Mannheim gold is composed of copper, zinc, and tin, in proportions about as follows:

	I.	II.
Copper	83.7	89.8
Zinc	9.3	9.9
Tin	7.0	0.6

It has a fine yellow color, and was formerly much used in making buttons and pressed articles resembling gold. Later alloys, however, surpass it in color, and it has fallen somewhat into disuse. One variety of Mannheim gold, so called, contains 1.40 parts of brass (composition 3 Cu_2 1 Zn) to 10 of copper and 0.1 of zinc.

CHRYSOCHALK OR GOLD COPPER.

Chrysochalk is similar in composition to Mannheim gold.

	I.	II.
Copper	90.5	58.68
Zinc	7.9	40.22
Lead	1.6	1.90

In color it resembles gold, but quickly loses its beauty if exposed to the air, on account of the oxidation of the copper. It can, however, be kept bright for a long time by a coating of colorless varnish, which excludes the air and prevents oxidation. Chrysochalk is used for most of the ordinary imitations of gold. Cheap watch chains and jewelry are manufactured from it, and it is widely used by the manufacturers of imitation bronze ornaments.

PINCHBECK.

Pinchbeck was first manufactured in England. Its dark gold color is the best imitation of gold alloyed with copper. Being very ductile, it can easily be rolled out into thin plates, which can be given any desired shape by stamping. It does not readily oxidize, and thus fulfills all the requirements for making cheap jewelry, which is its principal use. It is composed of copper and zinc, or copper, zinc, and brass, in the proportions given:

	I.	II.
Copper	88.8	93.6
Zinc	11.2	6.4
or		
Copper	2.0	1.28
Zinc	..	0.7
Brass	1.0	0.7

ORËIDE OR OROIDE (FRENCH GOLD).

The so-called French gold, when polished, so closely resembles genuine gold in color, that it can scarcely be distinguished from it. Besides its beautiful color, it has the valuable properties of being very ductile and tenacious, so that it can easily be stamped into any desired shape; it also takes a high polish. It is frequently used for the manufacture of spoons, forks, etc., but is unsuitable for this purpose on account of the large amount of copper contained in it, rendering it injurious to health. The directions for preparing this alloy vary greatly. The products of some Paris factories show the following composition:

	I.	II.	III.
Copper	90	80.5	86.21
Zinc	10	14.5	31.52
Tin	..	...	0.48
Iron	..	...	0.24

A special receipt for orëide is the following:

Melt 100 parts of copper, and add, with constant stirring, 6 parts of magnesia, 3.6 of sal ammoniac, 1.8 of lime, and 9 of crude tartar. Stir again thoroughly, and add 17 parts of granulated zinc, and after mixing it with the copper by vigorous stirring, keep the alloy liquid for one hour. Then carefully remove the cover of froth and pour off the alloy.

TALMI GOLD.

The name of talmi gold was first applied to articles of jewelry, chains, earrings, bracelets, etc., brought from Paris, and distinguished by beautiful workmanship, a low price, and great durability. Later, when this alloy had acquired a considerable reputation, articles were introduced under the same name, but really made of other metals, and which retained their beautiful gold color only as long as they were not used. The fine varieties of talmi gold are manufactured from brass, copper, or tombac, covered with a thin plate of gold, combined with the base by rolling, under strong pressure. The plates are then rolled out by passing through rollers and the coating not only acquires considerable density, but adheres so closely to the base that the metal will keep its beautiful appearance for years. Of late, many articles of talmi gold are brought into the market whose gold coating is produced by electro-plating, and is in many cases so thin that hard rubbing will bring through the color of the base. Such articles, of course, are not durable. In genuine talmi gold, the coating, even though it may be thin, adheres very closely to the base, for the reason that the two metals are actually joined by the rolling, and also because alloyed gold is always used, which is much harder than pure gold. The pure gold of electro-plating is very soft. The composition of some varieties of talmi gold are here given. It will be seen that the content of gold varies greatly, and the durability of the alloy will of course correspond to this. The alloys I., II., III. are genuine Paris talmi gold; IV., V., and VI. are electro-plated imitations; and VII. is an alloy of a wrong composition, to which the gold does not adhere firmly.

	I.	II.	III.	IV.	V.	VI.	VII.
Copper.....	89.88	90.79	90.00	90.69 88.16	87.48	93.46 84.55	86.4
Zinc.....	9.32	8.33	8.9	88.97 11.42	12.44	6.00 15.79	12.2
Tin.....	....	....	.....	... .	..	...	1.1
Iron.....	....	....	.....	... .	...	...	0.3
Gold.....	1.00	0.97	0.91	0.3	0.3	0.05	....

TISSIER'S METAL.

This alloy differs from the ones previously described in containing arsenic. It is of a beautiful tombac red color, and very hard. Its composition varies a great deal, but the peculiar alloy which gives the name is composed of copper 97 parts, zinc 2 parts, arsenic 1 or 2. It may be considered a brass with a very high percentage of copper, and hardened by the addition of arsenic. It is sometimes used for axle bearings, but other alloys are equally suitable for this purpose, and are to be preferred on account of the absence of arsenic, which is always dangerous.

TOURNAY'S METAL.

This alloy is characterized by great ductility, and is much used on this account by the Paris manufacturers of bronze articles, and for the manufacture of imitation jewelry from thin sheets, for pressed buttons, etc. It is composed of copper 82.54 parts, zinc 17.46.

PLATINE.

Platine is a brass made of 80 parts of brass and 20 of copper, is white, and used especially for buttons.

LEAF BRASS.

This alloy is also called Dutch gold, or imitation gold leaf. It is made of copper 77.75 to 84.5 parts, zinc 15.5 to 22.25. Its color is pale or bright yellow or greenish, according to the proportions of the metals. It has an unusual degree of ductility.—Translated from Krupp "Die Legierungen."

ULTRA-VIOLET LIGHT FROM THE SUN.—K. Schwarzschild and W. Villiger have measured the distribution of ultra-violet light over the sun's disk by the simple expedient of photographing it by means of a lens of the new Jena ultra-violet glass, thinly silvered, according to Straubel's suggestion, to cut off the visible rays. A lens like that only transmits a narrow band of ultra-violet light extending from 315 to 327 $\mu\mu$, and is, therefore, a highly efficient filter. The photographs show that whereas the red rays only slightly fall off from the center to the edge of the disk, and the violet rays fall off very rapidly, this increase in the gradient is not maintained on proceeding further into the ultra-violet. Very near the disk the violet is more obliterated than the ultra-violet. The sun's atmosphere, therefore, affects ultra-violet light in a manner quite different from the earth's atmosphere.—Schwarzschild and Villiger, Physikalische Zeitschrift, November 1, 1905.

[Continued from SUPPLEMENT No. 1575, page 25236.]

CEMENT MORTAR AND CONCRETE: THEIR PREPARATION AND USE FOR FARM PURPOSES.*

By PHILIP L. WORMLEY, JR.

Concrete Exposed to Sea-Water.

PORTLAND cement concrete is well adapted for work exposed to sea-water, but when used for this purpose it should be mixed with fresh water. The concrete must be practically impervious, at least on the surface, and to accomplish this the materials should be carefully proportioned and thoroughly mixed. It is also of great importance that the concrete be well compacted by tamping, particularly on exposed surfaces.

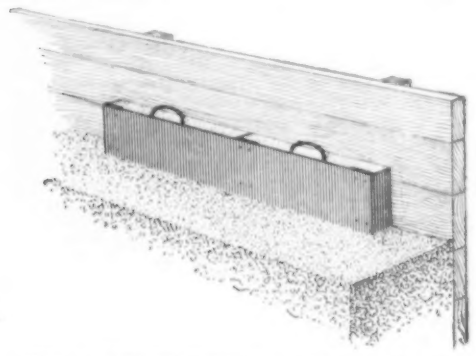


FIG. 1.—SHEET METAL PLATE USED IN FACING CONCRETE.

Concrete Work in Freezing Weather.

Although it is advisable under ordinary circumstances to discontinue cement work in freezing weather, Portland cement may be used without serious difficulty by taking a few simple precautions. As little water as possible should be used in mixing, to hasten the setting of the cement. To prevent freezing, hot water is frequently used in mixing mortar or concrete, and with the same object in view salt is added in amounts depending upon the degree of cold. A common practice is to add 1 pound of salt to 18 gallons of water, with the addition of 1 ounce of salt for each degree below 32 deg. F. Either of the above methods will give good results, but it should be remembered that the addition of salt often produces efflorescence. It seems to be a fairly well-established fact that concrete deposited in freezing weather will ultimately develop full strength, showing no injury due to the low temperature.

Rubble Concrete.

In massive concrete work considerable economy may often be introduced by the use of large stones in the body of the work, but only in heavy foundations, retaining walls, and similar structures should this form of construction be permitted. In placing these large stones in the work the greatest care must be exercised to insure each being well bedded, and the concrete must be thoroughly tamped around them. Each stone should be at least 4 inches from its neighbor and an equal distance from the face of the work.

To Face Concrete.

A coating of mortar ½ to 1 inch in thickness is frequently placed next the form to prevent the stone or gravel from showing and to give a smooth and impervious surface. If in preparing this mortar finely crushed stone is used instead of sand, the work will more nearly resemble natural stone. A common method employed in facing concrete is to provide a piece of thin sheet metal of convenient length and about 8 or 10 inches wide. To this pieces of angle iron are riveted, so that when placed next to the mold a narrow space is formed in which the cement mortar is placed after the concrete has been deposited behind it (Fig. 1). The metal plate is then withdrawn and the concrete well tamped. The concrete and facing mortar must be put in at the same time so that they will set together. If the concrete is fairly rich a smooth surface can usually be produced without a facing of mortar by working a spade up and down between the concrete and inner face of the mold, thus forcing the larger pieces of the aggregate back from the surface.

Wood for Forms.

Lumber used in making forms for concrete should be dressed on one side and both edges. The expansion and distortion of the wood due to the absorption of water from the concrete frequently make it difficult to produce an even surface on the work, and unless the forms are accurately fitted together more or less water will find its way out through the cracks, carrying some of the cement with it. A method sometimes adopted to minimize the effect of expansion is to bevel one edge of each board, allowing this edge to crush against the square edge of the adjacent board when expansion takes place. In the case of a wooden core or inside mold, expansion must always be taken into consideration, for if neglected it may cause cracks or complete rupture of the concrete. Sharp edges in concrete are easily chipped and should be avoided by placing triangular strips in the corners of molds. To prevent cement from sticking to the forms they may be given a coating of soft soap or be lined with paper. This greatly facilitates their removal and enables them to be used again with but little scraping. A wire brush answers best for cleaning the forms.

CONCRETE SIDEWALKS.

A useful and comparatively simple application of concrete is in the construction of sidewalks, for which purpose it has been used with marked success for a number of years.

Excavation and Preparation of Subgrade.

The ground is excavated to subgrade and well consolidated by ramming to prepare it for the subfoundation of stone, gravel, or cinders. The depth of excavation will depend upon the climate and nature of the ground, being deeper in localities where heavy frosts occur or where the ground is soft than in climates where there are no frosts. In the former case the excavation should be carried to a depth of 12 inches, whereas in the latter from 4 to 6 inches will be sufficient. No roots of trees should be left above subgrade.

The Subfoundation.

The subfoundation consists of a layer of loose material, such as broken stone, gravel, or cinders, spread over the subgrade and well tamped to secure a firm base for the main foundation of concrete which is placed on top. It is most important that the subfoundation be well drained to prevent the accumulation of water, which, upon freezing, would lift and crack the walk. For this purpose it is well to provide drain tile at suitable points to carry off any water which may collect under the concrete. An average thickness for subfoundation is 4 to 6 inches, although in warm climates, if the ground is firm and well drained, the subfoundation may be only 2 to 3 inches thick or omitted altogether.

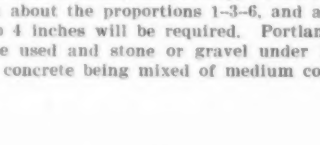


FIG. 3.—JOINTER USED IN DIVIDING WALK INTO SECTIONS.

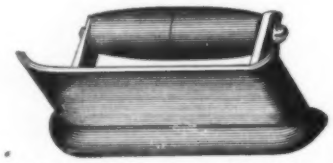


FIG. 4.—TOOL USED IN ROUNDING EDGES.

The Foundation.

The foundation consists of a layer of concrete deposited on the subfoundation and carrying a surface layer or wearing coat of cement mortar. If the ground is firm and the subfoundation well rammed in place and properly drained, great strength will not be required of the concrete, which may, in such cases, be mixed in about the proportions 1–3–6, and a depth of only 3 to 4 inches will be required. Portland cement should be used and stone or gravel under 1 inch in size, the concrete being mixed of medium consistency, so that moisture will show on the surface without excessive tamping.

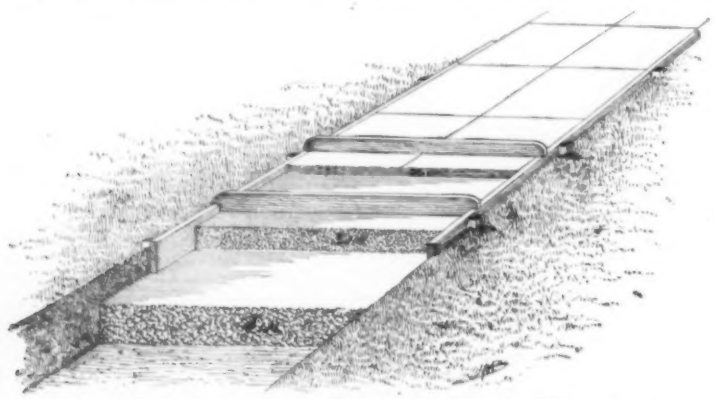


FIG. 2.—DETAILS OF CONCRETE WALK CONSTRUCTION.

The Top Dressing or Wearing Surface.

To give a neat appearance to the finished walk, a top dressing of cement mortar is spread over the concrete, well worked in, and brought to a perfectly smooth surface with straightedge and float. This mortar should be mixed in the proportion 1 part cement to 2 parts sand, sharp coarse sand or screenings below one-fourth inch of some hard, tough rock being used. The practice of making the concrete of natural cement and the wearing surface of Portland is not to be commended, owing to a tendency for the two to separate.

FIG. 5.—ROLLER USED IN FINISHING SURFACE.

Details of Construction.

A cord stretched between stakes will serve as a guide in excavating, after which the bottom of the trench is well consolidated by ramming, any loose material below subgrade being replaced by sand or gravel. The material to form the subgrade is then spread over the bottom of the trench to the desired thickness and thoroughly compacted. Next, stakes are driven along the sides of the walk, spaced 4 to 6 feet apart, and their tops made even with the finished surface of the walk, which should have a transverse slope of one-fourth inch to the foot for drainage. Wooden strips at least 1½ inches thick, and of suitable depth, are nailed to these stakes to serve as a mold for the concrete. By carefully adjusting these strips to the exact height of the stakes they may be used as guides for the straightedge in leveling off the concrete and wearing surface. The subfoundation is well sprinkled to receive the concrete, which is deposited in the usual manner, well tamped behind a board set vertically across the trench, and leveled off with a straightedge as shown in Fig. 2, leaving one-half to 1 inch for the wearing surface. Three-eighths inch sand joints are provided at intervals of 6 to 8 feet to prevent expansion cracks, or, in case of settlement, to confine the cracks to these joints. This is done either by depositing the concrete in sections, or by dividing it into such sections with a spade when soft and filling the joints with sand. The location of each joint is marked on the wooden frame for future reference.

Care must be exercised to prevent sand or any other material from being dropped on the concrete, and thus preventing a proper union with the wearing surface. No section should be left partially completed to be finished with the next batch or left until the following day. Any concrete left after the completion of a section should be mixed with the next batch.

It is of the utmost importance to follow up closely the concrete work with the top dressing in order that the two may set together. This top dressing should be worked well over the concrete with a trowel, and leveled with a straightedge (Fig. 2) to secure an even surface. Upon the thoroughness of this operation often depends the success or failure of the walk, since a good bond between the wearing surface and concrete base is absolutely essential. The mortar should be mixed rather stiff. As soon as the film of water begins to leave the surface, a wooden float is used, followed up by a plasterer's trowel, the operation being similar to that of plastering a wall. The floating, though necessary to give a smooth surface, will, if continued too long, bring a thin layer of neat cement to the surface and probably cause the walk to crack.

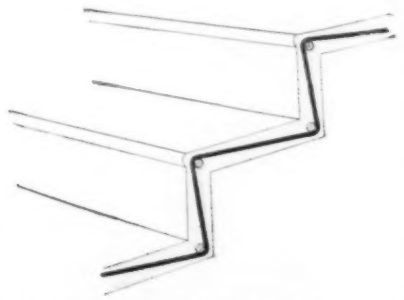


FIG. 6.—REINFORCED CONCRETE STEPS.

The surface is now divided into sections by cutting

* Reprint from Farmers' Bulletin, No. 235, issued by the Department of Agriculture.

entirely through, exactly over the joints in the concrete. This is done with a trovel guided by a straightedge, after which the edges are rounded off with a special tool called a jointer, having a thin shallow tongue (Fig. 3). These sections may be subdivided in any manner desired for the sake of appearance.

A special tool called an edger (Fig. 4) is run around the outside of the walk next to the mold, giving it a neat rounded edge. A toothed roller (Fig. 5) having small projections on its face is frequently used to produce slight indentations on the surface, adding somewhat to the appearance of the walk. The completed work must be protected from the sun and kept moist by sprinkling for several days. In freezing weather the same precautions should be taken as in other classes of concrete work.

CONCRETE BASEMENT FLOORS.

Basement floors in dwelling houses as a rule require only a moderate degree of strength, although in cases of very wet basements, where water pressure from beneath has to be resisted, greater strength is required than would otherwise be necessary. The subfoundation should be well drained, sometimes requiring the use of tile for carrying off the water. The rules given for constructing concrete sidewalks apply equally well to basement floors. The thickness of the concrete foundation is usually from 3 to 5 inches, according to strength desired, and for average work a 1–3–6 mixture is sufficiently rich. Expansion joints are frequently omitted, since the temperature variation is less than in outside work, but since this omission not infrequently gives rise to unsightly cracks, their use is recommended in all cases. It will usually be sufficient to divide a room of moderate size into four equal sections, separated by one-half inch sand joints. The floor should be given a slight slope toward the center or one corner, with provision at the lowest point for carrying off any water that may accumulate.

CONCRETE STABLE FLOORS AND DRIVEWAYS.

Concrete stable floors and driveways are constructed in the same general way as basement floors and sidewalks, but with a thicker foundation, on account of the greater strength required. The foundation may well be 6 inches thick, with a 1-inch wearing surface. An objection sometimes raised against concrete driveways is that they become slippery when wet; but this fault is in a great measure overcome by dividing the wearing surface into small squares about 4 inches on the side, by means of triangular grooves three-eighths of an inch deep. This gives a very neat appearance and furnishes a good foothold for horses.

CONCRETE STEPS.

Concrete may be advantageously used in the construction of steps, particularly in damp places, such as areaways and cellars of houses; and in the open, where the ground is terraced, concrete steps and walks can be made exceedingly attractive. Where the ground is firm it may be cut away as nearly as possible in the form of steps, with each step left 2 or 3 inches below its finished level. The steps are formed, beginning at the top, by depositing the concrete behind vertical boards so placed as to give the necessary thickness to the risers and projecting high enough to serve as a guide in leveling off the tread. Such steps may be reinforced where greater strength is desired or where there is danger of cracking, due to settlement of the ground.

Where the nature of the ground will not admit of its being cut away in the form of steps, the risers are molded between two vertical forms. The front one may be a smooth board, but the other should be a piece of thin sheet metal, which is more easily removed after the earth has been tamped in behind it. A simple method of reinforcing steps is to place a half-inch steel rod in each corner, and thread these with quarter-inch rods bent to the shape of the steps, as shown in Fig. 6, the latter being placed about 2 feet apart. For this class of work a rich Portland cement concrete is recommended, with the use of stone or gravel under one-half inch in size. Steps may be given a half-inch wearing surface of cement mortar mixed in the proportion 1 part cement to 2 parts sand. This system, as well as many others, is well adapted for stairways in houses.

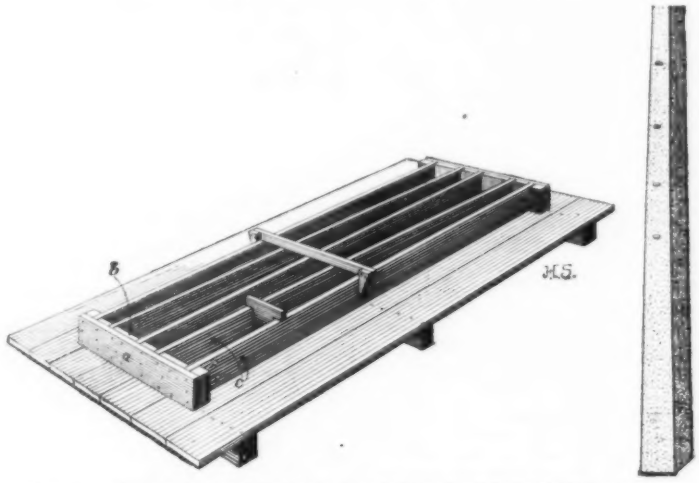


FIG. 7.—WOODEN MOLD FOR MAKING FENCE POSTS WITH TWO TAPERING SIDES.

REINFORCED CONCRETE FENCE POSTS.

Comparison of Different Post Materials.

There is a constantly increasing demand for some form of fence post which is not subject to decay. The life of wooden posts is very limited, and the scarcity of suitable timber in many localities has made it imperative to find a substitute. A fence post, to prove thoroughly satisfactory, must fulfill three conditions: (1) It must be obtainable at a reasonable cost; (2) it must possess sufficient strength to meet the demands of general farm use; (3) it must not be subject to decay and must be able to withstand successfully the effects of water, frost, and fire. Although iron posts of various designs are frequently used for ornamental purposes, their adoption for general farm use is prohibited by their excessive cost. Then, too, iron posts exposed to the weather are subject to corrosion, to prevent which necessitates repainting from time to time, and this item will entail considerable expense in cases where a large number of posts are to be used.

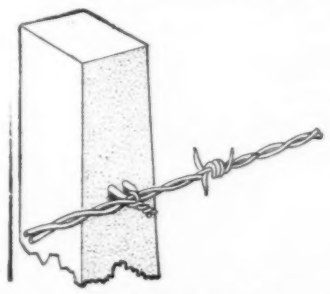


FIG. 9.—DETAIL SHOWING METHOD OF ATTACHING WIRE TO POST.

At the present time the material which seems most nearly to meet these requirements is reinforced concrete. The idea of constructing fence posts of concrete reinforced with iron or steel is by no means a new one, but on the contrary such posts have been experimented with for years, and a great number of patents have been issued covering many of the possible forms of reinforcement. It is frequently stated that a reinforced concrete post can be made and put in the ground for the same price as a wooden post. Of course this will depend in any locality upon the relative value of wood and the various materials which go to make up the concrete post, but in the great majority of cases, wood will prove the cheaper material in regard to first cost. On the other hand, a concrete post will last indefinitely, its strength increasing with age, whereas the wooden post must be replaced at short intervals, probably making it more expensive in the long run.

In regard to strength, it must be borne in mind that it is not practicable to make concrete fence posts as strong as wooden posts of the same size; but since wooden posts, as a rule, are many times stronger than is necessary, this difference in strength should not condemn the use of reinforced concrete for this purpose. Moreover, strength in many cases is of little importance, the fence being used only as a dividing line, and in such cases small concrete posts provide ample strength and present a very uniform and neat appearance. In any case, to enable concrete posts to withstand the loads they are called upon to carry, sufficient strength may be secured by means of reinforcement, and where great strength is required this may be obtained by using a larger post with a greater proportion of metal and well braced, as is usual in such cases. In point of durability, concrete is unsurpassed by any material of construction. It offers a perfect protection to the metal reinforcement and is not itself affected by exposure, so that a post constructed of concrete reinforced with steel will last indefinitely, and require no attention in the way of repairs.

Reinforcement.

No form of wooden reinforcement, either on the surface or within the post, can be recommended. If on the surface, the wood will soon decay, and if a wooden core is used it will in all probability swell by the absorption of moisture and crack the post. The use of galvanized wire is sometimes advocated, but if the post is properly constructed and a good concrete used, this precaution against rust will be unnecessary, since it has been fully demonstrated by repeated tests that concrete protects steel perfectly against rust. If plain, smooth wire or rods are used for reinforcement they should be bent over at the ends or looped to prevent slipping in the concrete. Twisted fence wire may usually be obtained at a reasonable cost and is very well suited for this purpose. Barbed wire has been proposed and is sometimes used, although the barbs make it extremely difficult to handle. For the sake of economy the smallest amount of metal consistent with the desired strength must be used, and this requirement makes it necessary to place the reinforcement near the surface, where its strength is utilized to greatest advantage, with only enough concrete on the outside to form a protective covering. A reinforcing member in each corner of the post is probably the most efficient arrangement.

Concrete for Fence Posts.

The concrete should be mixed with Portland cement in about the proportion 1–2½–5, broken stone or gravel under one-half inch being used. In cases where the aggregate contains pieces smaller than one-fourth inch, less sand may be used, and in some cases it may be omitted altogether. A mixture of medium consistency is recommended on the ground that it fills the molds better, and with less tamping than if mixed quite dry.

Molds for Fence Posts.

Economy points to the use of a tapering post, which, fortunately, offers no difficulties in the way of molding. All things considered wooden molds will be found most suitable. They can be easily and quickly made in any desired size and form. Posts may be molded either in a vertical or horizontal position, the latter being the simpler and better method. If molded vertically a wet mixture is necessary, requiring a longer time to set, with the consequent delay in removing the molds. Fig. 7 shows a simple mold, which has been used with satisfactory results in this laboratory. This mold has a capacity of four posts, but larger molds could easily be made on the same principle. It consists of two end pieces, *a*, carrying lugs, *b*, between which are inserted strips, *c*. The several parts are held together with hooks and eyes, as shown in Fig. 7. To prevent any bulging of the side strips they are braced, as illustrated. Dressed lumber at least 1 inch thick, and preferably 1½ inches, should be used. In Fig. 7 the post measures 6 by 6 inches at the bottom, 6 by 3 inches at the top, and 7 feet in length, having two parallel sides. If it is desired to have the posts square at both ends the mold must be arranged as in Fig 8. This latter form of post is not as strong as the former, but requires less concrete in its construction. Great care in tamping is necessary to insure the corners of the mold being well filled, and if this detail is not carefully watched, the metal, being exposed in places, will be subject to rust.

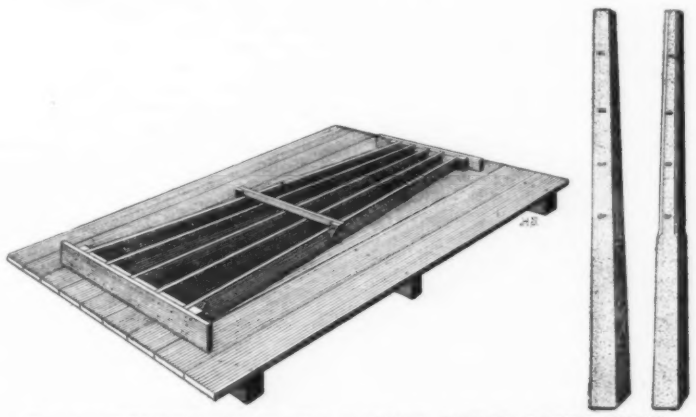


FIG. 8.—WOODEN MOLD FOR MAKING FENCE POSTS WITH FOUR TAPERING SIDES.

Attaching Fence Wires to Posts.

Various devices have been suggested for attaching fence wires to the posts, the object of each being to secure a simple and permanent fastener or one admitting of easy renewal at any time. Probably nothing will answer the purpose better than a long staple or bent wire well embedded in the concrete, being twisted or bent at the end to prevent extraction. Galvanized metal must be used for fasteners since they are not protected by the concrete. A piece of small flexible wire, about 2 inches in length, threading the staple and twisted several times with a pair of pliers, holds the line wire in position (Fig. 9).

(To be continued.)

PRODUCER GAS AND GAS PRODUCERS.*

By CHARLES H. DAY.

AT first all attempts to produce gas from coal were made only to get a form of gas suitable for illuminating purposes, namely, one high in hydrocarbons. Such a gas was best made by distilling coal in closed retorts, which made a gas of very high quality, but also very expensive. Mudoch was the first to adopt this scheme and his gas was, roughly speaking, two-thirds hydrogen, carbon, and hydrocarbons.

Recently, however, there has been a strong demand for a cheaper gas, brought about chiefly because of the growing in favor of large gas engines. At first it was considered impossible for large gas engines to be operated as economically as steam engines, solely because of the difficulty of obtaining a suitable gas that was not too expensive.

The numerous advantages of gas as a fuel have long been known and all depend to a great extent on the fact that the amount of air necessary for combustion under ordinary circumstances is about twice that which is theoretically required. The chief advantages are:

(1) More complete combustion; (2) easy control of the air and gas supply and consequently the combustion; (3) higher possible temperatures; (4) less heat loss up the chimney; (5) no loss of fuel through grates; (6) no irregularities of firing; (7) greater efficiency in transfer of heat due to higher temperatures; (8) availability of heat of waste gases to preheat the air.

A certain theoretical amount of air is necessary for any combustion. This amount is variable and with direct firing it is hard to regulate. As the air has to come up through the bed of coals, more air will be used when the fire is thin and the fuel in large-sized pieces. While burning, the coal is apt to break up and stop up the air passages; this is especially true of bituminous coal. Also, more air is required to consume the volatile matter when a fresh charge is put into the furnace. This greater amount of air is needed at a time when the passages through the fire bed are the smallest.

With gas as a fuel, the air supply may be made to agree more closely with the theoretical and is easier to control. This means that the products of combustion are less diluted with inert nitrogen and other gases that retard combustion. Also, as the heat evolved is concentrated into a smaller volume the temperature of combustion is higher and the oxygen of the air tends to unite more readily with the gas. Because of their reduced quantity the burnt gases take away less heat from the system. The heat being of a higher temperature is more easily transferred to the working medium.

The method employed to produce a suitable and sufficiently cheap gas for power purposes is burning the coal with an insufficient supply of air furnished by passing a blast of air and steam through the fire.

The oxygen of the air first enters into chemical composition with the carbon of the fuel, forming carbon dioxid. This carbon dioxid, passing up through the incandescent coal, takes up more oxygen and is changed into carbon monoxide:

$$C + CO_2 + \text{heat} = 2CO.$$

When water in the form of steam is mixed with the air blast and comes in contact with the burning fuel the hydrogen is liberated, and the oxygen unites and forms more carbon monoxid:

$$C + H_2O + \text{heat} = H_2 + CO.$$

To these products must be added the volatile matter that is distilled off the top of the fuel bed. This consists for most part of marsh gas (CH_4) and hydrogen. The other main constituent of the gas is the nitrogen of the air first passing up through the fire.

At the temperature of about 1,900 degrees Fahr., the minimum of carbon dioxid is formed when the air is passed over glowing carbon; this, therefore, is theoretically the best temperature at which to work the producer. The percentage of carbon dioxid will also be less when the surface of the fire is greater. Other things which tend toward a greater production of carbon monoxid are porous fuel and a finely-divided and deep bed, although these features must not be carried beyond the point where excessive resistance to the air-blast occurs. A weaker blast is also beneficial because it gives longer contact between the fuel and the blast.

The volatile gases given up by uncarbonized fuel are also dependent on the temperature. The percentage of combustibles, especially carbon monoxid, is greater when the temperature of the producer is higher and the gases contain a greater proportion of the energy of the coal, although less gas is produced per unit of carbon. With high temperatures the tendency is more toward the production of pitch and soot than toward that of tar. Tests of a producer comparing hot and cold working of the same fuel showed a 20 per cent higher heating value of the gas obtained with the producer hot, while the volume decreased 12 per cent.

With other conditions constant, the temperature of the producer will increase with the amount of fuel changed into gas in a specified length of time, and this is dependent on the amount of air supplied. Increasing the air supply, however, increases the rapidity of combustion, increases the velocity of the blast through the fuel bed, decreases the time of contact of the blast with the fuel, and if the percentage of carbon dioxide is to be kept low, requires a greater depth of bed.

The use of steam with the air-blast, while it reduces somewhat the temperature of the fire, is beneficial in many respects. With a moderate amount of steam, the combustibles are increased by the addition of the hydrogen, the inert nitrogen is decreased, the calorific power is raised, and the temperature of the gas leaving the producer is lowered. With too much steam, the temperature of the fire is lowered to such a point that excessive carbon dioxid is formed.

Per Cent by Volume.

	Amount of Steam.	
	Moderate.	Excessive.
CO_2	5.30	8.90
CO	23.50	16.40
CH_4	3.30	2.55
H	13.14	18.60

In the primary combustion of carbon to carbon monoxid 1 pound of carbon burns to 2.33 pounds of carbon monoxid, generating 4,400 heat units or about 30 per cent of the total energy of the carbon. During the secondary combustion, CO to CO_2, the 2.33 pounds of CO burn to 3.66 pounds of CO_2, and liberate 10,101 heat units, or about 70 per cent. If the heat of the primary combustion were not utilized, either to impart a higher temperature to the gas or to break up the water, only 70 per cent of the energy of the coal would be carried away by the gas.

About three-fifths of this 30 per cent is reclaimed in practice by the use of economizers to pre-heat the air-blast. Assuming that 1 pound of carbon is oxidized by the water for every 5 pounds burned, the following will take place:

5 pounds of carbon burned to CO (4 pounds gasified with oxygen of air and 1 pound with oxygen of water) yields	22,000 B. t. u.
1.5 pounds water (which furnish 1.33 pounds of oxygen to combine with 1 pound of carbon) absorb	10,330 B. t. u.
Gas consisting of 11.66 pounds of CO 0.167 pound of hydrogen, 17.884 pounds of nitrogen, heated to 600 degrees, absorbs	4,675 B. t. u.
Leaving for radiation and loss	6,995 B. t. u.
Totals	22,000 — 22,000

Charging up all the sensible heat of the gas, the radiation, etc., to the loss account, the gas carries ($5 \times 14{,}500$) — ($4{,}765 + 7{,}095$) = 60,640 heat units and the efficiency of the transfer is 84 per cent. The heat necessary to generate the steam is not taken into account, neither is the heat lost in burning from 4 to 7 per cent of the carbon to CO_2. This last item is partly used to break up more steam and so the loss is not as great as it would seem on first sight. Since one-fifth of the required oxygen is furnished by the water, 5.79 pounds less air is necessary, and the gas contains 4.46 pounds less nitrogen.

By the use of a gas producer, fuels that are ordinarily unsuited for the production of heat, such as lignites, brown coals, tan bark and peat, may be used. The most common fuels used in this work are anthracite and bituminous coals.

Of anthracite coal from 2 to 7 per cent is volatile matter. As the amount of marsh gas in the producer gas corresponds almost exactly to the amount of volatile matter in the coal gasified, it is safe to assume that this volatile matter is CH_4, and that all the free hydrogen comes from the water vapor.

Assume a sample of coal to show the following analysis: Carbon, 83 per cent; volatile matter, 7 per cent; ash, 10 per cent; five pounds of carbon burned to CO_2 and 78 pounds to CO; 80 per cent of the oxygen obtained from the atmosphere and the other 20 per cent from the steam. The following results will be obtained:

	Lbs.	Cu. Ft.	Per Cent by Volume.	Energy.
78 pounds burned to CO	182.1	2,470.0	31.5	780,000
7 pounds burned to CO_2	25.7	230.5	2.8	.....
5 pounds hydrocarbons distilled	5.0	116.5	1.5	117,500
123 pounds oxygen required, for which 24.6 from H_2O liberated hydrogen	3.0	568.0	7.3	186,000
98.4 pounds oxygen from air liberated nitrogen	331.0	4,470.0	56.9	.....
Totals	546.8	7,845.0	100.0	1,083,500

Energy per pound of gas	2,050 B. t. u.
Energy per cubic foot of gas	139.5 B. t. u.
Energy in coal:	
85 pounds carbon burned to CO_2	1,237,000 B. t. u.
5 pounds of CH_4 burned to $CO_2 + H_2O$	117,500 B. t. u.
Total per 100 pounds	1,354,500 B. t. u.

$$\text{Efficiency} = \frac{1{,}083{,}500}{1{,}354{,}500} = 0.807, \text{ or } 80.7 \text{ per cent.}$$

To illustrate the loss due to the formation of CO_2, when none of the heat liberated by the primary combustion is used to break up water vapor, the following table is given of the gases obtained theoretically when different quantities of the carbon are burned to CO_2. The statement of the percentage of energy given to the gas does not take into account the fact that the increase in the percentage of the inert nitrogen reduces the energy efficiency in the poorer gases.

100 pounds of carbon gasified with air:

Pounds of carbon reduced to CO_2	0	5	10	15	25	50
Per cent of CO	34.4	31.5	29.5	26.6	22.7	12.9
Per cent of CO_2	.....	1.6	3.2	4.6	7.6	12.9
Per cent of N	65.6	66.9	67.3	68.8	69.7	74.2
Pounds of gas	679	708	737	766	824	969
Cu. ft. of gas	9,185	9,468	9,750	10,065	10,587	12,189
Per cent of carbon energy in gas	70.0	66.0	63.0	59.0	52.0	35.0
B. t. u. per cu. ft.	109.7	100.5	94.1	85.8	72.0	41.1

Taking into account the heat liberated when 100 pounds of carbon are burned to CO_2, and 70 per cent of this heat is used to break up water the following results are obtained:

	Lbs.	Cu. Ft.	Per Cent by Volume.
100 pounds of carbon to CO_2 produces 70 per cent of 1,450,000 = 1,105,000: this liberates from water, hydrogen amounting to	366.67	3,153	25.4
130.96 pounds oxygen from H_2O combines with 49.2 pounds carbon to form CO_2; 50.8 pounds of carbon combine with 135.13 pounds atmospheric oxygen, which liberates nitrogen amounting to	16.33	3,110	25.1
	453.00	6,115	49.5
Totals	836.00	12,378	100.0

From this it is evident that 70 per cent of the carbon energy is contained in 836 pounds of gas, or $0.70/836 = 0.088$ per cent in one pound of gas. Burning carbon to CO, 70 per cent of the carbon energy is contained in 679 pounds, or $0.70/679 = 0.103$ per cent in one pound of gas. Thus when carbon dioxid is formed and the heat used to break up water, the energy is used in a very poor way. In special cases, however, where the sensible heat of the gas is used and where the conditions for good combustion are bad, a hot gas with from 8 to 10 per cent of CO_2 is found to be better than a cold gas low in CO_2.

Bituminous-coal producer gas differs from anthracite gas only in that it contains a higher per cent of hydrocarbons. Also, when the gas from this coal is cooled much below 300 degrees, these hydrocarbons are apt to condense.

Assume a coal to contain 70 per cent carbon, 20 per cent CH_4, and 10 per cent ash; 80 per cent of the required oxygen to be obtained from the air, and five pounds of the carbon to be burned to CO_2. Then we would obtain the following results:

	Lbs.	Cu. Ft.	Per Cent by Volume.	B. T. U. Energy.
65 pounds carbon burned to CO	151.6	2,054.0	30.4	657,000
5 pounds carbon burned to CO_2	18.3	157.6	2.3	.....
20 pounds CH_4 distilled	20.0	466.0	6.9	471,000
100 pounds oxygen required, of which 20 pounds from H_2O liberates hydrogen amounting to	2.5	474.0	7.0	155,000
80 pounds oxygen from air liberates nitrogen amounting to	268.0	3,610.0	53.4	.....
Totals	460.4	6,761.6	100.0	1,283,000

Energy per pound of gas	2,780 B. t. u.
Energy per cubic foot	190 B. t. u.
Energy in the coal:	
70 pounds C burned to CO_2	1,019,000 B. t. u.
20 pounds CH_4 burned to CO_2 and H_2O	471,000 B. t. u.
Total per 100 pounds	1,490,000 B. t. u.

$$\text{Efficiency} = \frac{1{,}283{,}000}{1{,}490{,}000} = 0.864, \text{ or } 86.4 \text{ per cent.}$$

Primarily, there are two types of gas producers; pressure and suction. The pressure type occupies more space, but at the same time permits a greater range in the quality of the fuel to be gasified. So far, suction producers have not been very much developed, except in the smaller sizes, but manufacturers are gradually putting on the market successful suction producers in sizes of several hundred horse-power. However, today the general practice is to use pressure producers for plants of a capacity greater than 200 horse-power, or where more than one engine is working on the same system.

In a pressure producer the air and steam are furnished to the bottom of the fire-bed under a pressure of from 2 to 8 inches of water. The blast, which is superheated, passes up through the incandescent coal, forming gas, as already described. The gas next passes into the economizer, where it is made to heat separately the air and the steam. At the bottom of the economizer is a water seal, to prevent the gas in the holder from backing up through the producers and causing explosions. From the economizer the gas passes into the scrubber, consisting of a number of trays filled with coke over which water is kept continually running. This operation removes all the dirt, part of the tarry matter, sulphur, etc., and cools the gas. The purifier, usually made up of trays of dry sawdust, finishes the operation of cleaning the gas, which is then led to the holder. When the gas contains much sulphur, oxidized iron filings are mixed with the sawdust to remove it, and prevent the forma-

* From Power.

tion of sulphuric acid in the cylinder of the engine. The holder acts more as a pressure regulator and mixer than a reservoir, for it is rarely large enough to hold gas to supply the engine for any length of time. By means of an automatic connection between the holder and the main steam supply, the steam is shut off when the holder is filled. The top of the producer is usually jacketed to keep it cool, and this jacket water is generally used to supply the water seal of the tank.

Anthracite or bituminous coal, lignites, coke, charcoal, peat, tan bark, etc., may all be used in a pressure producer, the design of which has to fit the conditions of the case. The best results are obtained from anthracite coal. No. 1 buckwheat is a very satisfactory coal, and is the one most used in working producers. This is sometimes mixed with breeze from coke or coal bins.

The soft coal producer plant is a little more complicated and expensive, both as regards first cost and operation, and if anthracite coal were not very much more expensive than bituminous, it would undoubtedly not be put in. The following table shows what may be expected for the analysis, and shows that the gas is of a fairly uniform composition:

No.	1	2	3	4	5	6	7
CO_2	8.6	8.2	6.0	1.7	4.1	2.5	2.0
O	0.4	0.8					
CO	17.2	19.4	22.0	29.8	23.7	27.0	27.0
H	18.3	16.6	15.0	7.2	8.0	12.0	12.0
CH_4	2.4	2.6	3.0	1.5	2.2	1.2	2.5
N	53.1	52.2	54.0	59.8	62.0	57.3	56.5
Totals	100.0	100.0	100.0	100.0	100.0	100.0	100.0

The suction producer owes its working to the vacuum formed by the suction stroke of the gas engine. As no holder is required, a great saving in first cost and space is obtained. The gas on leaving the producer passes through a vaporizer, where part of its sensible heat is utilized to convert water into steam and to heat the air. The gas then passes through a scrubber, purifier, etc., and finally to the engine cylinder. For starting purposes a small hand-blower is provided and the gas at first is allowed to escape into the air. When the gas has a rich enough quality this bypass is closed and the engine started. After this the operation is practically automatic.

In this type of producer only anthracite coal has been used with any degree of success, and, because of the resistance to the air blast that it offers, it should not be smaller than pea size. A coal that contains more than 10 to 15 per cent of ash tends to choke up the air passages and obstructs the cleaning of the generator, and therefore should not be used unless it is absolutely unavoidable. Also, a coal that contains very much moisture or more than from 5 to 8 per cent of volatile matter tends to cohere and to form arches which prevent the proper working of the plant. Unless special stress is laid on purification, the coal should contain as little tar as possible. Tar tends to clog up the pipes and valves, forms a slow-burning mixture, and causes premature explosions in the engine cylinder.

The gas is very similar in composition to that obtained from a pressure producer and averages about as follows:

Carbon dioxid	8.0
Carbon monoxid	26.0
Hydrogen	18.5
Marsh Gas	0.5
Nitrogen	47.0
Total	100.0

METHODS FOR INCREASING THE TRANSMITTER ENERGY IN WIRELESS TELEGRAPHY.

IN 1898 Prof. F. Braun suggested some arrangements for wireless telegraphy senders, which are being called "coupled systems," and where the open circuit of the sender, instead of being excited direct, as according to Marconi, is connected to an "oscillation circuit," consisting of condensers with inserted self-inductions and serving as a reservoir of energy. As pointed out by the experimenter in No. 8 of the Physikalische Zeitschrift (April 15, 1904), there are two possibilities of increasing the energy disposable for radiation ($\frac{1}{2} CV^2$, where V is the potential to which the Leyden jars are charged), namely, first, increasing the capacity, and, second, augmenting the charging tension. Both of these are discussed in the present paper. As the coupling effect of the whole system is shown to decrease for decreasing self-inductions of the oscillation circuit, the capacity of the condensers cannot be augmented at will. In addition to this theoretical obstacle to an unlimited increase, there is also the practical impossibility of increasing the capacity without inserting into the condenser the self-inductions due to the armature and connections. As regards the other alternative, viz., increasing the charging tension, there are likewise practical limits dependent on the electrical rigidity of the insulators. On the other hand, there is the impossibility, shown by experience, of increasing without limit and with a satisfactory efficiency the spark length necessitated by the augmented charging tensions.

The author accordingly tried to find some method allowing of the energy disposable for radiation being increased without altering the period of oscillation, so as to enable the economy of a single Leyden jar circuit to be used. The first arrangement devised consisted of a number of condenser circuits of strictly identical periods, connected in series, the sender traversing the whole system (Fig. 5). Another arrangement consisted of condensers charged in parallel by means of ohmic or inductive resistances w_1, w_2, and w_3 (Fig. 2). As soon as one of the sparks is started, the others will

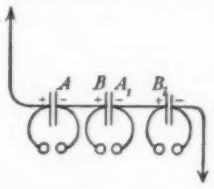


FIG. 1.

pass as well, when the whole circuit is completed, and the high charging resistances, as is well known, are practically eliminated. Experiments have shown the sparks in this system to behave like those in an individual system, while, on the other hand, no appreciable phase difference is found to exist. It is evident that the energy may be utilized inductively in any type of arrangement. This is shown in Fig. 3 for the case of a series arrangement. The advantage of these arrangements is the fact that the energy is augmented by charging at a low tension with the elements connected in parallel, and connecting the elements in series only for the discharge. No neighboring elements will accordingly be driven to tension differences exceeding the practical limits of insulation.

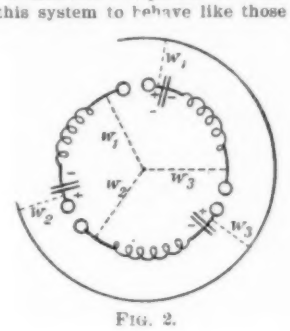


FIG. 2.

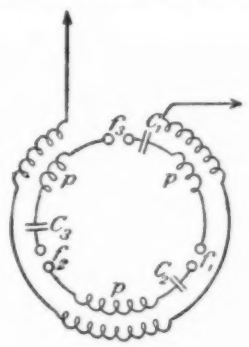


FIG. 3.

The problem next discussed is as follows:

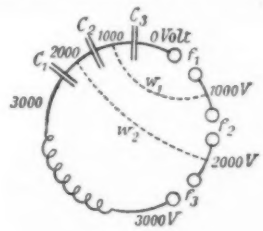


FIG. 4.

In the case of a discharge tension higher than those corresponding to the most favorable spark lengths having to be used, the consumption of energy in the spark should nevertheless be maintained at this minimum value. An arrangement corresponding to this desideratum is represented in Fig. 4, where w_1 and w_2 represent high resistances, and the figures 3,000, 2,000, 1,000, and 0 are initial potentials.

The author's method of measuring phase displacements, as finally considered, is based on exciting by induction electromotive forces in two secondary coils with a coupling as loose as possible, and on measuring a magnitude proportional to the electromotive force resulting from the two individual forces in the case of the coils being connected either in series or in opposition; both components have to be made strictly identical before the experiment. (See Fig. 5.)

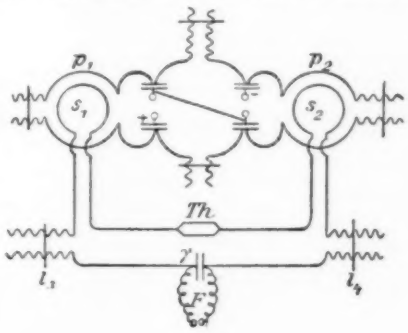


FIG. 5.

CONTEMPORARY ELECTRICAL SCIENCE.*

THE ELECTRON THEORY.—W. Wien reviews the present position of the electron theory, and touches upon some outstanding difficulties which have yet to be overcome. One of these lies in the constitution of the electron itself, which may possibly never be elucidated. The theory is bound to ascribe a definite size to it. If its shape is spherical that size may be calculated, and it comes out as about a billionth of a millimeter. The concentration of an electric charge upon so small a volume would, according to our ordinary conceptions, bring enormous forces into play, which would tend to destroy the electron. It is, of course, hardly admissible to assume the existence of parts and forces within a particle that is supposed to be indivisible. Another difficulty lies in the permanence of the spectrum lines —i. e., the periods of vibration or revolution of the electrons in the atom. The radiation emitted by them must damp these vibrations in the course of time, and it remains to be explained how the energy received from external radiations is utilized to maintain the standard rates of revolution. Gravitation, also, is not yet reduced to E.M.F.'s, though several ingenious attempts in this direction have been made. They all, however, require new assumptions of a somewhat artificial kind.—W. Wien, Physikalische Zeitschrift, November 9, 1905.

A NEW HEAT ENGINE.—M. Cantor makes an interesting communication with regard to a new principle in heat engines. It is well known that the efficiency of a heat engine depends upon the amount of expansion of the gases employed, that is to say, upon the ratio of the final to the initial volume. Successive expansions extend this ratio in one direction, and initial pressure extends it in the other. But no initial pressure capable of solidifying the gas and thus reducing it to the smallest possible initial volume, has yet been employed. The author indicates a theoretical method of doing this. The engine contains incandescent oxide of copper, and it is worked by blowing some liquid fuel, say petroleum, through the incandescent mass. The liquid fuel and the solid oxygen have therefore a very small initial volume, the oxygen being reduced to 1-7,000 of its ordinary volume. The metallic copper is re-oxidized by a current of oxygen, and the heat gained in this oxidation may be also utilized. The method as proposed may, of course, not be practicable, but it indicates a path along which further great improvements in the efficiency of heat engines are theoretically possible.—M. Cantor, Physikalische Zeitschrift, November 9, 1905.

HEUSLER'S MAGNETIC ALLOYS.—B. V. Hill has made some further discoveries in connection with the magnetic alloys of non-magnetic metals discovered by Heusler. He finds that they show an irreversibility with regard to high temperatures, just as the nickel steels show an irreversibility with regard to low temperatures. He worked with an alloy containing 60 per cent copper, 25 per cent manganese, and 15 per cent aluminium, and another alloy containing more aluminium. The latter showed an induction $B = 5{,}750$ c.g.s. in a field $H = 87$ c.g.s., with a comparatively large hysteresis. It was then subjected to repeated heating and cooling. Starting with a magnetic intensity of 311 units, the curve fell till it reached the axis at 320 deg. On cooling, the magnetization was found to be only 267 units. On heating again, the magnetization did not disappear completely, but remained as high as 7 up to 500 deg. On cooling, it appeared much diminished, being only 27 deg. at ordinary temperatures and 36 deg. at the temperature of liquid air. The author attempted to restore the magnetization by heating to dull redness, but only attained an intensity of magnetization of 90 units. Heating to a bright red made this 155 units, and subsequent exposure to liquid air 165 units. The other alloy, heated to 950 deg., lost its magnetism permanently and became 14 per cent lighter. The nickel steels are heavier in the non-magnetic state. —B. V. Hill, Physical Review, November, 1905.

VERY SOFT RÖNTGEN RAYS.—When the vacuum in a Röntgen tube is successively reduced, the velocity of the cathode rays and the intensity of the Röntgen rays diminish simultaneously. When the E.M.F. falls below 30,000 volts the fluorescent screen and the photographic plate cease to show any effect. W. Seitz has inquired whether this is due to a cessation of production of X-rays or to a cessation of their penetrating power thus preventing them from traversing the glass wall of the tube. To decide this question, he replaced a portion of the glass wall by an aluminium partition, and found a vigorous production of X-rays down to voltages as low as 600. So long as the glow-light reaches the anti-cathode, X-rays pass through the aluminium window. Their photographic action is particularly strong. Probably they are more freely absorbed by the film than the harder rays, and are thus more fully utilized. Action upon bacteria is also very strong, but it is correspondingly superficial. Between 1,500 and 6,000 volts, an aluminium film of 0.00075 centimeter thickness absorbs more than half the rays. The difference in the penetration through the various metals is less marked than in the harder rays. There is no magnetic deflection.—W. Seitz, Physikalische Zeitschrift, November 9, 1905.

* Compiled by E. E. Fournier d'Albe in the Electrician.

SNAIL CLLTURE IN BURGUNDY.*

By JACQUES BOYER.

SNAIL culture was practiced by the Romans in the time of the civil war between Cæsar and Pompey. The

A SNAILERY AT DANNEMOINE, NEAR TONNERRE, BURGUNDY. FEEDING THE SNAILS WITH LETTUCE, CABBAGE, AND GRASS.

largest snails came from Illyria and the finest from the promontory of Salitum in Africa. Pliny, the elder, ascribes to Fulvius Hirpinus the idea of imprisoning the mollusks in pens and fattening them with a paste composed of flour, boiled wine, and other ingredients, and Petronius informs us that Trinalcion had snails broiled and served on a silver gridiron. During the Middle Ages this picturesque industry became established in Switzerland and the Danubian provinces. At this period, owing to the difficulty of communication, perishable articles of food were seldom brought into the interior of countries. For this reason, according to Dr. Langeron, the suburbs of Ulm sold annually ten million snails to the Austrian convents, where the mollusks were eaten during the rigorous fast of Lent, under the name of fish.

The provinces of Aunis and Saintonge exported snails by the shipload, even to the West Indies, before the French Revolution, but snails did not appear on Parisian tables until a much later date. They came into vogue in the following way: At the end of the eighteenth century travelers who had occasion to visit Burgundy were compelled to stop at the post inns, in several of which snails, gathered in the vineyards, were served to them. Among these inns, one in particular—that of "Père Vallée," at Basson—rapidly acquired the universal esteem of the wine merchants of Bercy, who came every year to make their purchases in that district. These merchants very properly extolled the new dish that they had encountered in their travels and so their friends begged them to introduce it into the capital. In consequence, the "Black Hen" and the "Gray Hen"—coaches plying between Paris and Auxerre—were commissioned to bring to the "Ville Lumière" the first baskets of snails that appeared in the Basson market.

In 1830 three Bercy restaurants, the "Marroniers," the "Penpliero" and the "Maison du Grand Saint Louis," received several hundred snails each week, during the season. Twenty years later the trade in Burgundy snails was greatly increased by the establishment of railways. "Père Vallée" had found imitators and the humble snail had permanently won the favor of French epicures.

The appearance of the vineyard snail is too familiar to need minute description. Naturalists class it among gasteropod mollusks and call it *Helix pomatia*.

Like the philosopher of antiquity, it carries its house with it, this house being a nearly flat spiral shell into which the animal withdraws completely when alarmed and in which it passes the winter. The two superior tentacles, or "horns," which adorn its head are longer than the inferior pair and bear organs of vision at their extremities. The mouth contains a very hard, horny tongue and a masticating apparatus powerful enough to grind leaves, upon which the animal entirely subsists. This vegetarian diet, however, nourishes muscles of astonishing strength. A snail can drag along with ease an object weighing seventy times as much as itself, to which it is attached in the manner of a cupping glass or "sucker," while a horse can draw only twice its own weight.

PREPARATION OF THE FORCE MEAT WITH WHICH THE SHELLS ARE FILLED.

The snail is very prolific, laying 50 to 60 eggs annually. The eggs, which are globular, gelatinous, and inclosed in exceedingly thin calcareous shells, are deposited, in a cohering mass, in a smooth hole prepared for them in the ground, and hatch in twenty days. The newly hatched snails have very delicate shells, which harden quickly on contact with the air. They grow so rapidly that they are ready for market in October, that is to say, six or eight weeks after hatching. Many of the young snails are destroyed by birds, toads and insects.

In most parts of France snails were formerly gathered in vineyards and hedgerows; now they are bred and fattened in special establishments called *escargotières*, or snaileries. This picturesque industry, however, is two thousand years old, as we have already noted. Columella and Varro have bequeathed us some information of the *cochlearum vivaria* of Rome, which occupied large spaces entirely surrounded by water. Here, on beds of moss and grass, the fortunate mollusks enjoyed a cool and salubrious climate produced by the spray of fountains. The French snaileries of the Yonne, the Lura, the Cote d'Or, the Rhone, and the Aube, and those of Würtemberg, and the Swiss canton of Appenzell are not better managed than their Roman prototypes.

A snail park is made by selecting a plot of damp and calcareous soil and inclosing it with smoothly planed boards, coated with tar, and held in place by outside stakes strong enough to withstand the force of the wind. The boards must penetrate the soil to a depth of eight inches, at least, and at the level of the ground they must have a sort of shoulder, or shelf, to prevent the snails from burrowing under them. When the mollusk encounters an obstacle in its path it proceeds to lay eggs. According to Larbalétrier, a plot of two hundred square meters is sufficient for ten thousand snails. The ground is plowed deeply, and on a rainy evening in March or April the snails are introduced and covered with from two to four inches of moss or straw, which is sprinkled when it becomes too dry.

REMOVING THE "CORK," OR EPIPHRAGM FROM THE MOUTH OF THE SHELL.

Under the influence of heat and moisture the mollusks bury themselves in the ground or take refuge in the bushes until the breeding season. Their food, supplied daily, consists of lettuce, romaine, cabbage, and vine leaves, or, in default of these, grass. But the food must be appetizing, for snails are very fastidious. In consideration of their nocturnal habits it is spread in the snailery shortly before sunset. A few herbs—chervil, mint, parsley, and savory—are planted in the inclosure to improve the flavor of the snails. It was formerly believed that these aromatic herbs attracted the snails, which were supposed to have an exquisitely keen scent. But, according to the recent researches of Young, of Geneva, though snails perceive odors by means of the entire surface of the body outside of the shell, their sense of smell is poorly developed. Young has even proved, by repeated experiments, that the limit of olfactory perception does not exceed sixteen inches. Beyond this distance a snail cannot detect the fragrance of an over-ripe melon—its favorite food—and it sometimes feeds on belladonna, rose laurel, and other poisonous plants. Several cases of poisoning have been caused by eating snails gathered from such plants.

In October the snails, which have become very fat, "cork themselves up," that is to say, they retire within their shells, the mouths of which they close with a thin, calcareous pellicle or epiphragm. Then they are taken from the park and placed on "screens," or trays, which are piled together in great storehouses. Here the snails remain several months without food. In this respect they far surpass the fakirs of India, who, it is

SNAIL CULTURE IN BURGUNDY.

* From American Homes and Gardens. Published by Munn & Co.

fabled, lie buried for weeks. According to the observations of H. Ancapitaine, indeed, snails can fast for two or three years.

When the snail grower judges that the fast has been sufficiently prolonged, or when the winter demand for snails begins the trays are taken down and the snails examined by the women, who reject the dead and remove the "corks," or epiphragms, of the living animals.

Then, after girls have brushed the shells, to remove earthy matter, the snails are placed under a water tap, where a man stirs them with a shovel to facilitate thorough washing.

The snails are then cooked in salt water in a great pot which holds about ten thousand. This operation is performed two or three times a day, according to the demand and the size of the establishment, for the snails, to reach the consumer in good condition, must be cooked and shipped on the same day.

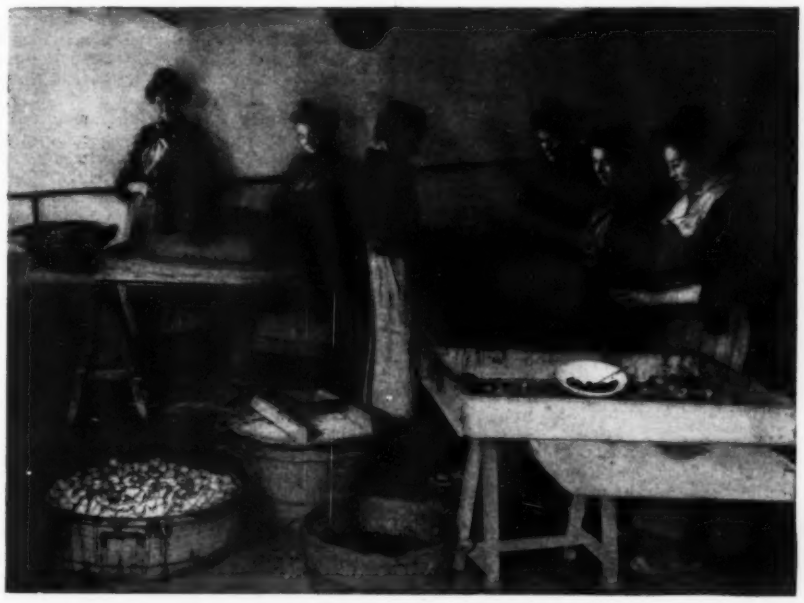
After the cooking comes the "cleaning," which consists in extracting the snail from the shell, drying the latter and refilling it with the meat, reduced to a paste and laid between two layers of unsalted butter, seasoned with finely chopped chervil, shallots, and parsley.

The preparation of the *escargots à la bourguignonne*, or "Burgundy snails," is now finished. All that remains is to pack them in wooden boxes nolding 50, 100 or 200, for private consumers, or in larger packages for restaurants, shops and agents at the Halles (the great market of Paris).

In Burgundy the sale of prepared snails extends from the middle of September to the end of April. In the south of France it begins earlier and ends later, and includes a second species of snail, *Helix melanostoma*, which, under the name of *terrassau*, is in great demand at Marseilles and constitutes one of the greatest delicacies of the epicure.

COOKING THE SNAILS.

WASHING AND BRUSHING SNAILS.



CLEANING AND FILLING THE SHELLS.

SNAIL CULTURE IN BURGUNDY.

HYDRODYNAMICS: ITS EVOLUTION.

THE theory of the equilibrium of liquids, even when they are being rotated, was well understood prior to the last century, thanks to Maclaurin (1742), Clairut (1743), and Lagrange (1788). The generalizations of Jacobi (1834) contributed the triaxial ellipsoid of revolution and the case has been extended to two rotating attracting masses by Poincaré (1885) and Darwin (1887). The astonishing revelations contained in the recent work of Poincaré are particularly noteworthy.

Unlike elastics, theoretical hydrodynamics passed into the nineteenth century in a relatively well-developed state. Both types of the Eulerian equations of motion (1755, 1759) had left the hands of Lagrange (1788) in their present form. In relatively recent times, H. Weber (1868) transformed them in a way combining certain advantages of both, and another transformation was undertaken by Clebsch (1859). Hankel (1861) modified the equation of continuity, and Svanberg and Edlund (1847) the surface conditions.

Helmholtz in his epoch-making paper of 1858 divided the subject into those classes of motion (flow in tubes, streams, jets, waves) for which a velocity potential exists and the vortex motions for which it does not exist. This classification was carried even into higher orders of motion by Craig and by Rowland (1881). For cases with a velocity potential, much progress has been made during the century in the treatment of waves, of discontinuous fluid motion, and in the dynamics of solids suspended in frictionless liquids. Kelland (1844), Scott Russel (1844), and Green (1837) dealt with the motion of progressive waves in relatively shallow vessels, Gerster (1804) and Rankine (1863) with progressive waves in deep water, while Stokes (1846, 1847, 1880), after digesting the cotemporaneous advances in hydrodynamics, brought his powerful mind to bear on most of the outstanding difficulties. Kelvin introduced the case of ripples (1871), afterward treated by Rayleigh (1883). The solitary wave of Russel occupied Boussinesq (1872, 1882), Rayleigh (1876), and others; group waves were treated by Reynolds (1877), and Rayleigh (1879). Finally the theory of stationary waves received extended attention in the writings of De St. Venant (1871), Kirchhoff (1879), and Greenhill (1887). Early experimental guidance was given by the classic researches of C. H. and W. Weber (1825).

The occurrence of discontinuous variation of velocity within the liquid was first fully appreciated by Helmholtz (1868), later by Kirchhoff (1869), Rayleigh (1876), Voigt (1885), and others. It lends itself well to conformal representations.

The motions of solids within a liquid have fascinated many investigators and it is chiefly in connection with this subject that the method of sources and sinks was developed by English mathematicians following Kelvin's method (1856) for the flow of heat. The problem of the sphere was solved more or less completely by Poisson (1832), Stokes (1843), Dirichlet (1852); the problem of the ellipsoid by Green (1833), Clebsch (1858), generalized by Kirchhoff (1869). Rankine treated the translatory motion of cylinders and ellipsoids in a way bearing on the resistance of ships. Stokes (1843) and Kirchhoff entertain the question of more than one body. The motion of rings has occupied Kirchhoff (1869), Boltzmann (1871), Kelvin (1871), Bjerknes (1879), and others. The results of C. A. Bjerknes (1868) on the fields of hydrodynamic force surrounding spheres, pulsating or oscillating, in translatory or rotational motion accentuate the remarkable similarity of these fields with the corresponding cases in electricity and magnetism and have been edited in a unique monograph (1900) by his son. In a special category belong certain powerful researches with a practical bearing, such as the modern treatment of ballistics by Greenhill and of the ship propeller of Ressel (1826), summarized by Geriach (1885, 1886).

The numerous contributions of Kelvin (1888, 1889) in particular have thrown new light on the difficult but exceedingly important question of the stability of fluid motion.

The century, moreover, has extended the working theory of the tides due to Newton (1687) and Laplace (1774), through the labors of Airy, Kelvin, and Darwin.

Finally the forbidding subject of vortex motion was gradually approached more and more fully by Lagrange, Cauchy (1815, 1827), Svanberg (1839), Stokes (1845); but the epoch-making integrations of the differential equations together with singularly clear-cut interpretations of the whole subject are due to Helmholtz (1858). Kelvin (1867, 1883) soon recognized the importance of Helmholtz's work and extended it, and further advance came in particular from J. J. Thomson (1883) and Beltrami (1875). The conditions of stability in vortex motion were considered by Kelvin (1880), Lamb (1878), J. J. Thomson, and others, and the cases of one or more columnar vortices, of cylindrical vortex sheets, of one or more vortex rings simple or linked, have all yielded to treatment.

The indestructibility of vortex motion in a frictionless fluid, its open structure, the occurrence of reciprocal forces, were compared by Kelvin (1867) with the essential properties of the atom. Others, like Fitzgerald in his cobwebbed ether and Hicks (1885) in his vortex sponge, have found in the properties of vortices a clue to the possible structure of the ether. Yet it has not been possible to deduce the principles of dynamics from the vortex hypothesis, neither is the property which typifies the mass of an atom clearly discernible.

Kelvin invokes the corpuscular hypothesis of Lesage (1818).

REPORT OF ISTHMIAN CANAL COMMISSION FAVORING A HIGH-LEVEL CANAL.

THE Isthmian Canal Commission has received two reports from the Board of Consulting Engineers appointed by the President June 24, 1905, to consider plans for the construction of a canal across the Isthmus of Panama. The board was unable to reach a unanimous agreement. One of the reports is signed by eight members, and recommends a canal at sea level. The other is signed by the remaining five members, and recommends a canal with a summit level 85 feet above the sea, to be reached by locks.

Before proceeding to a review of these two reports it is desirable to remove certain misapprehensions as to the meaning of the terms "canal at sea level" and "canal with locks" as defining the character of the completed waterway. In the popular mind the one means a waterway affording navigation without restriction, while the other means a waterway in which navigation is delayed and hampered by mechanical appliances, and decidedly inferior to the former. These conceptions are quite inaccurate.

The ideal waterway through the Isthmus would be a channel at the sea level, of which the width would be greater than the length of the vessels using it. With any less width it is liable to the accident of being completely blocked by the sinking of a vessel transverse to its axis. If vessels 900 feet long are to be accommodated, the width should be considerably greater than 900 feet. A channel of this size can not be considered and has never been proposed. The enormous cost of the excavation has compelled all engineers who have considered the question to reduce the width to that strictly necessary to pass the largest vessels at greatly reduced speed. A width of 150 to 200 feet is now proposed, and is believed to be the greatest width economically permissible for the sea-level canal. It is very far, however, from furnishing unrestricted navigation. The speed of very large vessels, like the new Cunarders, must be reduced to 4 miles per hour or less, while two such vessels could not pass each other in the canal. Between this and the ideal canal are many degrees of size and convenience.

In a canal with locks, artificial lakes are created in which for considerable distances the navigation is entirely unrestricted. The advantages thus gained may more than counterbalance the delay and risk in the use of locks, and it is quite conceivable that a canal with locks may be a better canal—that is, can be navigated in less time and with less risk than a canal at sea level.

A discussion of the relative advantages and disadvantages of the canal at sea level and the canal with locks is to be approached then without prejudice in favor of either as a means of transit.

SEA-LEVEL PLAN.

The plan recommended by the majority of the board is a canal at the sea level, following essentially the line heretofore adopted by Congress, except near the terminals, the depth to be 40 feet, and the width at bottom to be 150 feet where the side slopes are gent[illegible] and 200 feet where the side slopes are nearly verti[illegible] as in rock. The least area of cross section is 8,276 [illegible] feet. At the Panama end is a tide lock, having a usable length 1,000 feet, width 100 feet, and depth over the miter sills 40 feet. In Panama Bay the channel is to be 35 feet deep at extreme low water of spring tides, which will give the full 40 feet provided elsewhere in the canal, except upon rare occasions.

To control the Chagres River, a dam of masonry, or of earth and masonry, is proposed at Gamboa, just off the line of the canal, built to a height 180 feet above the sea, forming a reservoir called Gamboa Lake, of which the maximum flow line is to be at elevation 170, into which the flood waters are to be received, but no design therefor is submitted.

This dam is to be fitted with controlling sluices by which a maximum discharge of 15,000 cubic feet per second is to be admitted to the canal prism, all in excess of that amount being temporarily stored until the subsidence of the flood. Of the tributaries entering the Chagres below Gamboa, the most important are diverted entirely from the canal and conducted by separate channels to the sea. There will still remain a number of tributaries and other streams to be taken into the canal. Their volume is assumed by the Board to be such that, added to the 15,000 cubic feet to be admitted through the sluices, they will create currents of which the highest mean velocity is computed by the majority to be 2.6 miles per hour. Ordinarily the velocity will not exceed 1 mile per hour.

Extensive harbor improvements are proposed at Colon.

The cost of the canal under this plan is estimated by the majority at $247,000,000. From the nature of the case this estimate can not be made with great precision. The quantity of each class of work to be done can, as a rule, be accurately measured, but the unit price for each class must be largely a matter of judgment. It is the opinion of this Commission that the unit prices adopted by the Board are, upon the whole, judicious, except in the case of rock excavation under water, which seems to us low, but is accepted here for purposes of comparison; and that otherwise the estimates are as near an approximation to the truth as can now be reached, in all except two items. These items are the excavation in Culebra Cut below elevation + 10, given on page 51 of the report as $20,242,877.50; and the completion of river diversions, regulation of rivers flowing into the canal, etc., given on page 58 as $3,500,000.

The first item covers 16,194,302 cubic yards of excavation, of which 11,439,612 cubic yards is below and the remainder above the level of the sea. The majority of the Board has adopted a uniform unit price of $1.25 per cubic yard for the whole. This price seems fair for the portion above the level of the sea. For the portion below, it seems to the Commission that the price of rock excavation under water, $2.50 per cubic yard, should be applied here as it is in the adjacent sections of the canal by the Board. If that be done, the cost of this item will be increased $14,299,515, and adding the usual 20 per cent for contingencies, the estimate will be increased $17,159,418.

The estimate, $3,500,000, of the cost of completing the river diversions, formation of dams across tributary streams, regulation of rivers which flow into the canal, etc., is believed to be too low. To show the magnitude of this feature of a sea-level canal a table is presented giving the names of the more important streams which enter the site of the canal, the distance of the point of junction from the Caribbean end of the canal, the height above sea level of their junction with the Chagres, Obispo, or Rio Grande Rivers, and the volume of discharge at high stage as far as observed or estimated. It must be remembered that while gagings of the Chagres at several points have been systematically carried through the river year covering both low waters and floods, nothing of this sort has been done on the other streams, where gagings have only been made desultorily, at such times and for such periods as were convenient. The discharges given in the table are in many instances obtained by distributing the total discharge of a considerable number of tributaries of the Chagres among the individual tributaries, according to the areas of their drainage basins. There is no certainty that this gives the maximum discharge for any one tributary, but the probability is that it does not.

Name.	Distance, Miles.	Greatest Observed Discharge, Sec. Feet.	Elevation at Mouth Above Sea Level, Feet.
Streams diverted:			
Mindi	5	.....	.....
Gatun	6.2	16,100	.....
Trinidad	9.6	18,500	.....
Gigante, left bank	18 91	2,158	30
Cano, left bank	19.84	9,006	33
Streams not diverted:			
Aojeta	15.15	1,000	15
Agua Salude, right bank	16.30	2,300	25
Frijolito, right bank	17.36	1,000	20
Frijoles Grande, right bank	17.98	3,740	26
Agua Bendita, left bank	21.96	800	35
Caimito Mulato, left bank	22.32	3 0	35
Baila Monos, left bank	22.61	1,775	45
Culo Seco, left bank	23.87	300	40
Pisco, right bank	24.18	1,200	34
Juan Grande, right bank	25.11	1,200	38
Carabali, left bank	25.42	760	40
Quatre Calles, right bank	26.66	500	45
Obispo	27.90	3,700	160
Mandingo, left bank	28.80	1,500	45
Camacho, left bank	29.10	1,349	165
Sardinilla	30.30	800	165
Rio Grande, right bank	34.72	600	120
Mallejon, right bank	36.80	.....	35
Pedro Miguel, left bank	37.07	.....	15
Caimitillo, left bank	37.82	.....	13
Rio Cocoli	38.90	.....	.....
Rio Cardenas	39.40	.....	.....

The Cano and the Gigante, the latter including its principal tributary, the Gigantito, are to be cut off by dams. The Trinidad will occupy the old channel of the Chagres River and the Chagres diversion. The Gatun will be cut off from the canal by the partly finished Gatun diversion, into which also will be conducted the Mindi River, which has not been gaged, but which is a stream of considerable importance. The others are to be taken into the canal. They must, however, be temporarily diverted during the excavation of the canal; and in the case of the Rio Grande this involves a tunnel seven-eighths of a mile long. In all the diversion channels together, the amount of excavation and levee building, with the necessary muck ditches and riprap levee and bank revetments, tunnels, etc., can not be less than 10,000,000 cubic yards. In view of the facts that in many cases the work is isolated and the field of operations narrow and contracted, that much special work, such as revetment, is required, and that the operations of excavation for channels and embankments for levees are separate and distinct, and that the material is not uniform, involving both earth and rock, the unit prices will be high.

The Cano and the Gigante are to be cut off by dams, lakes being thus created which will overflow through spillways provided in the divide near the heads of those streams. In this scheme four dams and three spillways are projected. The dam to close the Gigante will be about 2,800 feet long, that to close its main tributary, the Gigantito, will be about 490 feet long, and that to close the Cano about 820 feet long, the height in each case being about 75 feet above the ground, the depth to which the foundations must be sunk being unknown. A dam about 535 feet long and 25 feet high will be required to close a depression in the rim of one of the lakes. These and the spillways are expensive works. Their locations have never been examined by borings or exact topography, with the exception of the Gigante spillway. Their cost can not be accurately estimated without further examinations, but under favorable circumstances can hardly be less than $1,000,000.

The streams taken into the canal, whose beds at point of junction with the canal are considerably above the canal prism, are to "be discharged over masonry stepped aprons or through metallic discharge pipes, or these beds will be sloped and lowered so as to prevent objectionable currents at junction points." The elevation above sea level at which these streams reach the canal is given in the foregoing table, and varies from 13 to 165 feet. A provisional treatment of such important features of a sea-level canal should not be considered. From the point of view of thoroughness and permanency, the sloping and lowering of the beds so as to prevent objectionable currents at junction points would not be good practice. It may be surely anticipated that the accelerated velocity down the increased slope, unless its bottom and sides are lined with masonry, will operate with destructive effect both on the lowered channel and the bed and banks of the canal. Metallic discharge pipes are not adapted to this purpose on streams which are torrential in character and may bring with their flood drift trash and bowlders. The use of masonry-stepped aprons must therefore be considered, under the conditions presented by most of these streams, as the only advisable way of bringing them from a high to a low level. The construction of these would necessarily be very heavy and therefore very expensive. As in the case of the dams, the sites of these aprons have not been carefully examined, and the estimate of cost can only be a rough approximation. It is the opinion of the Commission that the sum of $3,500,000, assigned by the majority of the Board to the completion of the diversion channels, the construction of the dams and spillways, and the construction of these aprons, is inadequate, and should be increased by at least $6,500,000, which, with the usual 20 per cent added for contingencies, makes an increase of $7,800,000 to this item of the estimate.

If the foregoing increases be added to the $247,000,000 estimated by the majority of the Board, the cost of the sea-level canal will be found to be $272,000,000.

The time required to build the canal is estimated at twelve to thirteen years. The number of unknown factors which enter into this estimate is still greater than in the case of estimates of cost. There are two methods available for reaching a conclusion upon the subject. One is that followed by the Board, viz., to assume that the largest single piece of work—the Culebra Cut—will fix the time required, and that all other work can be completed while that is being executed, then to ascertain how many excavating machines can be employed at one time in the Culebra Cut, and then assign to each machine its daily or annual working capacity, under the conditions which prevail there. There is great uncertainty about all of these elements. The number of steam shovels which can work to advantage in Culebra Cut is not known, but is probably much less than the number mentioned in the report, 100; and there is no experience to show what the output of a steam shovel will be under all the extremely varying conditions which obtain there. The other method is to examine the results obtained in the great operations of the old French company in this same work. It is not unusual to hear that company spoken of lightly, but it is to be remembered that it had at its head men who had recently built the Suez Canal, that it had the advice of the best engineering talent in Europe, and that its pecuniary resources for some years were practically unlimited. After devoting the years 1881 and 1882 to preliminary work, it began operations on a large scale in the early part of 1883, and continued them until the latter part of 1888, about six years or seventy-two months. It excavated altogether about 72,000,000 cubic yards of material, or about 1,000,000 per month if we attribute the work of 1881 and 1882 to the later period, of which about one-third was the easy excavation with dredges in the coastal plains. In doing this it had every inducement that men could have to make haste. Its concession from Colombia for a limited period, its enormous interest charges, and the sanguine assurances of its promoters and managers, all urged the greatest possible speed. The wreckage along the line of the canal to-day is a demonstration of the feverish energy with which every species of machinery was lavished upon the work. To get the work done was the primary consideration, its cost secondary. The circumstances are now different in several important respects. There have been great improvements in excavating machinery, and means have been found to remove the terror of yellow fever, both of which conditions favor an increase of output. On the other hand, there must be a much more careful adjustment of the means to the end. Extravagant duplication of machinery, or other reckless expenditure, can not be tolerated. It is hoped and believed that a considerable increase over the French rate of progress can be attained. What the percentage will be is a matter of judgment, and is not capable of exact computation, but it would seem that the chances of error here are less than where all of the factors are unknown. Here at least the difference between spasmodic and long-continued effort, and the reduction of efficiency due to climate and distance from supplies are eliminated. In the opinion of the Commission it would not be unreasonable to hope for an increase of 25 per cent, which would give an average output of 1,250,000 cubic yards per month. To excavate the 231,000,000 cubic yards of the sea-level canal at this rate would require one hundred and eighty-five months or fifteen and one-half years. There would be at least two and one-half years at the beginning before this rate could be reached, and at least an equal amount of time at the end, during which the contracted space at the bottom of the cut would compel a reduction of force. It is to be feared that the time required to construct a sea-level canal would be eighteen or twenty years, rather than the twelve or thirteen years estimated by the majority, even supposing that the total amount of excavation will

not exceed the 231,000,000 cubic yards estimated. To reach that amount the majority of the Board has adopted steeper slopes in the Culebra cut than any previous board or commission has adjudged applicable. It may well happen that these slopes must be reduced, and the amount of excavation thus increased. The majority of the board has made no provision for the necessary turning-out places and widening at curves. It is not safe to estimate the time required for the construction of a sea-level canal at less than twenty years.

PLAN WITH LOCKS.

The plan recommended by the minority of the board is a canal with locks, following in general the same location as the other, but with slight variations therefrom in Limon and Panama bays. Its controlling feature is a dam to close the valley of the Chagres at Gatun, thus creating an artificial lake of which the surface is to be 85 feet above the sea and which is to constitute the summit level. The length of this dam will be 7,700 feet, and the height of its crest 135 feet, or 50 feet above the water surface. It will contain about 21,200,000 cubic yards of material, principally the spoil from the excavation of the canal prism. It is provided with ample spillways and regulating works. A channel 500 feet wide at sea level leads from Limon Bay to the Gatun dam, where is placed a double flight of three locks by means of which vessels are lifted into the artificial lake. The lake provides unrestricted navigation for a large part of its length, but becomes more contracted as the Continental Divide is approached until in the Culebra Cut the width at bottom is reduced to 200 feet. It finally terminates at Pedro Miguel, where the first lock on the Pacific side is placed, having a lift of 30 feet. By means of this lock vessels are lowered into another artificial lake created by a dam closing the valley of the Rio Grande, and by two other dams closing other depressions, the level of the lake being 55 feet above the sea. The crests of these dams are 80 feet above the sea. Communication between the lake and Panama Bay is effected by a double flight of two locks placed near the shore on the high ground called Sosa Hill. All locks are in duplicate and have a usable length 900 feet, width 95 feet, and depth over the miter sills 40 feet. The depth of the channel is everywhere at least 45 feet except in the locks and in Limon Bay, where it is 40 feet, the depth in Panama Bay, however, being measured from mean tide and not from dead low water. In the lakes the depth is often very much greater, being 75 feet near the Gatun dam, and nearly as much for many miles. The width is nowhere less than 200 feet at bottom, and at most places is very much more. The length of the canal from deep water in Limon Bay to deep water in Panama Bay is 49.72 miles. Of this 19½ miles is over 1,000 feet wide, 23 miles is over 800 feet wide, 35 miles is over 500 feet wide, and 42½ miles is over 300 feet wide. That is, for about half the distance navigation is entirely unrestricted; while for more than two-thirds the distance the channels are 500 feet or more wide, and for only one-seventh the distance, including the locks, are they less than 300 feet wide.

The cost of the canal under this plan is estimated by the minority of the board at $139,705,200, and the time required to build it at nine years. We consider both of these estimates reasonable, subject to the remarks already made concerning unit prices.

The plan recommended by the minority of the board is of the same type as that recommended by the Commission of 1899-1901 and adopted by Congress, at least by inference, in the act approved June 28, 1902. It provides wider and deeper channels and larger locks than that plan and a different arrangement of dams, as well as a change in the Atlantic entrance, but the height of the summit level is the same, and the estimates of cost and of the time required for construction are very nearly the same. Some of the changes have been made necessary by new requirements for navigation, and others have been the result of further study by fresh minds. They are improvements, such as Congress could not possibly have intended to prohibit when it adopted the old plan. They are of importance, but they do not seem to us to be changes of such radical character as would require further action by Congress, as in the case of a canal at sea level.

The only features of this plan which do not fall within the limits of every-day practice are the height and size of the dams and the size of the locks. No question has been raised as to the stability of the Gatun dam, and, indeed, none can be raised while there are in successful operation in this country earth dams of less cross section retaining a greater head of water. The great quantity of material available has made it possible to give this dam dimensions which are much greater than are strictly necessary. The majority of the board, however, do question the effectiveness of that dam in retaining water, expressing the fear that the subfoundation may be found so porous that seepage will be excessive. The minority point out that the material under the dam is exceptionably favorable, that for a depth of 200 feet it is practically impervious, and that the more porous material which is found for a short distance below that depth is covered with this impervious blanket 200 feet thick for a long distance upstream. They express the opinion, in which we concur, that there would be no appreciable seepage under the dam. In the case of the Rio Grande dam, the majority goes further and states that the earth dam proposed for that locality is in "danger of being pushed bodily out of place by the pressure due to the head of water in the reservoir," unless it be made very massive. In the opinion of the minority, in which we concur, the dam, as designed, is so massive that this is impossible. In this case, the greatest depth to rock is 64 feet, and all seepage can be cut off by sheet piling, if necessary; but the borings thus far indicate impervious material under the dam, and it is not expected that that device will be required.

The locks are larger than any which have heretofore been built, and the majority of the Board express the opinion that they are beyond the limit of prudent design. As a matter of fact, larger locks have been designed with the greatest prudence and with mathematical certainty. It can no more be said of lock building that it has reached the limit of judicious construction than of ship or bridge building or any other branch of engineering construction. A modern bridge of long span is a safer structure than the short span bridge of former days, because of better knowledge of the materials and improved methods of uniting them. So the proposed locks can be made safer than the Poe lock at the Sault, because they are designed after nine years of practical experience with that lock, an experience which shows it to be a safe place for a vessel.

It is our opinion that the entire feasibility of constructing the canal under the plan proposed by the minority of the board can not be successfully questioned.

RELATIVE EFFICIENCY OF COMPLETED CANALS.

The majority of the board express the opinion that the canal at sea level is the only one giving reasonable assurance of safe and uninterrupted navigation, and question the safety of large vessels in passing locks.

The most important ship canal in the world is that at the Saulte Ste. Marie, at the outlet of Lake Superior. The tonnage which it carries per annum is about three times that carried by the Suez Canal, and is greater than the aggregate tonnage of the Suez, Manchester, Kiel, and Amsterdam canals combined, although navigation is suspended several months each year by ice. One of its locks is the largest in existence, and during the season of navigation this lock alone carries three times the tonnage per month that the Suez Canal carries. It has been in successful operation since 1896, and has carried with ease and safety the largest vessels on the Great Lakes, some of them measuring 569 feet in length with 56 feet beam. The navigation interest has no fear of this lock. That interest is growing with marvelous rapidity, and is clamoring for deeper channels between the lakes, so that larger vessels may be used and larger locks built. No engineer who is familiar with this lock has any misgiving about its safety, or about the entire feasibility of building larger locks which shall be equally safe.

The majority of the Board have attempted to belittle this experience. They say it is not a "maritime canal." They explain that masters of vessels passing to and fro every few weeks acquire familiarity with the canal and locks, which leads to a degree of skill and safety which could never be attained in the Panama Canal, which would be visited only at rare intervals, forgetting that this acquired skill simply makes unnecessary the services of a pilot, and can never be equal to the skill of the special pilots who would be employed at Panama. They attach importance to the fact that navigation at the Sault is closed by ice for several months each year, at which time the locks can be pumped out and repaired, not stopping to consider that at Panama there are two sets of locks, one of which can be pumped out and repaired at any part of the year. They point to the three accidents which have occurred to the locks within the last nine years, and make certain speculations as to how near these were to being serious and what would have happened if the lift had been as great as that proposed for Panama, omitting to note that during the same period the open channels below were completely blocked three times, besides being partially blocked at other times, by the sinking of vessels. During each of the complete blockades in the open channel navigation was entirely suspended from two and a half to five days, and during the partial blockades all vessels were delayed from five to twenty-four hours, this state of affairs lasting in one case ten days. It is true that locks are subject to accident, but so are narrow channels without locks. In addition to the evidence just given, mention may be made of the steamer "Chatham," by which the Suez Canal was wholly blockaded for nine days, and partially blockaded for about a month in September and October, 1905. We can not concur in the opinion that a canal at sea level 150 feet wide gives "safe and uninterrupted navigation," least of all if, as in this case, that canal is liable to currents of 2.6 miles per hour. Moving in the same direction with such a current, it is doubtful whether one of the largest vessels now in use could navigate the canal at all with her own power. Nor can we concur in the opinion that a lock properly constructed and managed is in any sense a menace to the safety of vessels. Practical experience has demonstrated the contrary beyond dispute.

The volume of water contained in the proposed sea-level canal is about 100,664,000 cubic yards; that contained in the proposed canal with locks, omitting all below 45 feet depth and all beyond 1,000 feet width, is about 303,614,000 cubic yards. It is a fair statement that one waterway is three times the size of the other, and that but for the locks it affords three times the facilities for navigation.

In the canal at sea level there are many curves; in that with locks all the courses are straight, changes of direction being made at the intersection of tangents, where additional width is given. These straight courses can be marked with ranges, which greatly facilitate navigation, particularly at night.

In the canal at sea level there is often a considerable current, which at times becomes obstructive. In the canal with locks there is no such obstruction.

The time required to pass through a canal of either type differs with the size of the vessels and the number of vessels. Following the method described in the report of the Isthmian Canal Commission of 1901, the minority of the Board find that for a small ship the canal at sea level has the advantage by about thirty-six minutes, provided the number of ships does not exceed 10 per day. If the number of ships exceed 30 per day, the canal with locks has the advantage by about three hours. For large ships the canal with locks has the advantage whatever be the number per day. If the number be 10, the advantage is about thirty-six minutes; if it be 30, the advantage is over three and one-half hours. We believe these results to be approximately correct, assuming that there is no current in the canal. Should there be a current of 2.6 miles per hour, such as the sea-level canal is subject to, the time of passage through that canal might be greatly increased. It is assumed also that numerous turning-out places are provided in the sea-level canal, although for these no provision is made in the plan or the estimate.

The majority of the Board claim that locks limit the traffic capacity of the canal, that lockages perhaps can not exceed 10 per day for each lock, or 20 per day for the pair. The minority point to the experience at the Saulte, which shows that this estimate is not in accord with American practice, and they show that with the double flight of locks proposed a traffic of at least 80,000,000 tons per annum can be accommodated. Additional locks may be built hereafter if needed.

The majority in one place express the opinion that the canal at sea level "will endure for all time," page 64, and in another give weight to "the comparative ease and economy of enlarging the prism of the sea-level canal to accommodate any additional demands of the future," page 64. We estimate that to widen the sea-level canal 100 feet without deepening it will cost at least $87,000,000. To deepen it involves excavation under water throughout its length. The canal with locks may be deepened easily and cheaply by simply raising the crests of the spillways and the height of the locks.

The majority express the opinion that the cost of operating and maintaining a sea-level canal will be very much less than that for a canal with locks; and using the figures of the Commission of 1899-1901, they give the cost of operating and maintaining the locks at about $525,000 per annum. That estimate is probably as near an approximation to the truth as can now be given. The canal at sea level will require more dredging than the other, and it has one lock to be maintained. It must also be furnished with turn-out places and attendance there. A reasonable allowance for these expenses is $225,000, leaving $300,000 per annum as the apparent advantage in operating expenses of the sea-level canal. Against this is to be placed the interest on the additional investment. If the canal at sea level will cost $132,000,000 more than the canal with locks, as we believe it will, the interest on that sum is an additional fixed charge, and at 2 per cent amounts to $2,640,000 per annum; that is, the annual fixed charges of the canal at sea level will be $2,340,000 more than those of a canal with locks.

The majority of the board point to the ease with which an enemy might in time of war disable the locks with a few sticks of dynamite and lay much stress upon the disastrous results which would ensue to the United States should the passage be interrupted. The difficulty of defending the canal was clearly pointed out by the Commission of 1899-1901 who closed their discussion as follows, viz.: "It is the opinion of the Commission that a neutral canal, operated and controlled by American citizens, would materially add to the military strength of the United States; that a canal, whether neutral or not, controlled by foreigners, would be a source of weakness to the United States rather than of strength; and that a canal not neutral to be defended by the United States, whether by fortifications on land or by the navy at sea, would be a source of weakness." In that opinion we concur. It applies equally to a canal at sea level and to a canal with locks. In the former, the great dam at Gamboa and the other great dams, the steep slopes at Culebra, and the tide lock at Sosa all present points of attack, less favorable, no doubt, than the locks, but sufficiently so to make the canal entirely vulnerable. The canal at sea level can be blocked by sinking a vessel at any part of its length, while the canal with locks, for a large part of its length, can not be blocked in that manner at all. Should the United States depart from its true policy of making the canal neutral, it will not gain anything in a military point of view by adopting the canal at sea level in preference to the one with locks.

There is one valid argument, and one only, which can be brought against the canal with locks, and that is the difficulty of fixing the dimensions of the lock chambers to provide for the possible enlarged vessels of the future. The majority of the board propose a length of 1,000 feet, a width of 100 feet, and depth over the miter sills of 40 feet; while the minority propose a length of 900 feet, a width of 95 feet, and 40 feet over the miter sills. In the following table is a list giving the dimensions of 12 of the largest ships in the world and the ratio of their length and beam to their draft.

From this table it appears that the proportions suggested by the minority are more in accord with late practice than those suggested by the majority. If the locks are to be 1,000 feet long and 100 feet wide, apparently there should be greater depth over the miter sills. The minority point out that the dimensions proposed by them will provide for ships having 25 per cent more tonnage than the new Cunarders, and will permit the passage of battleships having 13 feet

Name of Steamer.	Steamship Line.	When Built	Length Over All, Feet.	Beam, Feet.	Maximum Loaded Draft, Feet.	Ratio of Draft to Beam and Length.
Kaiser Wilhelm der Grosse	North German Lloyd	1897	648.4	66.0	28.5	1 : 2.31 : 22.75
Kaiser Wilhelm II	" " "	1902	706.5	72.0	30.5	1 : 2.36 : 23.16
Kronprinz Wilhelm	" " "	1901	663.3	66.0	30.0	1 : 2.20 : 22.11
Oceanic	White Star	1899	705.6	68.4	35.7	1 : 1.91 : 19.76
Celtic	" "	1901	697.5	75.4	36.8	1 : 2.04 : 18.95
Cedric	" "	1903	697.5	75.4	36.9	1 : 2.04 : 18.90
Baltic	" "	1903	725.9	75.4	37.3	1 : 2.02 : 19.46
Deutschland	Hamburg-American	1900	687.5	67.3	31.0	1 : 2.17 : 22.17
Caronia	Cunard	1904	680.0	72.6	35.0	1 : 2.07 : 19.42
Carmania	"	1904	680.0	72.6	35.0	1 : 2.07 : 19.42
Two new ships, unnamed	"	1905-6	800.0	88.0	38.0	1 : 2.31 : 21.05
Average ratio						1 : 2.14 : 20.65

greater beam than any ship now in the United States navy. Inasmuch as the new Cunarders are not yet completed, are very much larger than any other vessels in existence, and must still be regarded as experimental, it seems to us that this is looking as far into the future as is expedient. If ships too large for these locks should hereafter be developed, it will be possible to add new and larger locks to accommodate them. The total estimated cost of all the locks and approach walls in the present project, including the contingency item of 20 per cent, is $44,425,000. They can therefore be entirely renewed for about half what it would cost to widen the sea-level canal 100 feet.

The water supply for the canal with locks as projected is sufficient to accommodate a traffic of about 50,000,000 tons annually. Should that traffic be exceeded in the future, the addition of a dam at Alhajuela will provide a supply sufficient for 100,000,000 tons. Should it be found necessary in the future to provide for the passage of a still larger tonnage, the Chagres River and its tributaries will furnish additional water.

The Board of Consulting Engineers is unanimous in the opinion, in which we concur, that if a sea-level canal is ever to be constructed it should be constructed as such from the first.

CONCLUSIONS AND RECOMMENDATIONS.

From the foregoing it appears that the canal proposed by the minority of the Board of Consulting Engineers can be built in half the time and a little more than half the cost of the canal proposed by the majority of the board, and that when completed it will be a better canal for the following reasons:

(1) It provides greater safety for ships and less danger of interruption to traffic by reason of its wider and deeper channels.

(2) It provides quicker passage across the Isthmus for large ships or a large traffic.

(3) It is in much less danger of damage to itself or of delays to ships from the flood waters of the Chagres and other streams.

(4) Its cost of operation and maintenance, including fixed charges, will be less by some $2,000,000 or more per annum.

(5) It can be enlarged hereafter much more easily and cheaply than can a sea-level canal.

(6) Its military defense can be effected with as little or, perhaps, less difficulty than the sea-level canal.

It is our opinion that the plan proposed by the minority of the Board of Consulting Engineers is a most satisfactory solution of the problem of an isthmian canal, and, therefore, we recommend that the plan of the minority be adopted, subject, of course, to such changes as may be found desirable during construction and with the understanding that the works in Limon Bay are to be deferred for the present. The entrance now in use at that place must, for the present, be used in any event, in order to secure harbor room for the landing of supplies immediately needed. The question whether or not it should be changed and what changes should be made can better be determined hereafter.

Respectfully submitted.

T. P. SHONTS, Chairman.
CHARLES E. MAGOON,
PETER C. HAINS,
Brigadier-General, U. S. Army, Retired.
O. H. ERNST,
Colonel of Engineers.
B. M. HARROD.

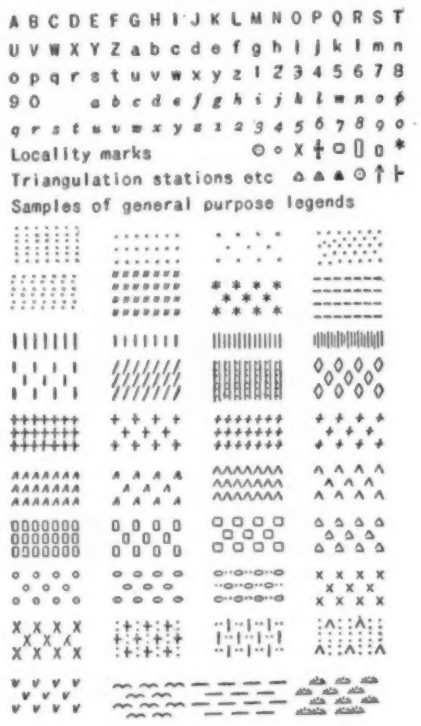
Hon. WM. H. TAFT,
Secretary of War, Washington, D. C.

MACHINE-MADE LINE DRAWINGS FOR THE ILLUSTRATION OF SCIENTIFIC PAPERS.

By R. A. DALY.

IT is safe to say that the majority of persons who from time to time publish scientific papers are seriously hampered in the preparation of text illustrations by the difficulty and expense entailed in the tedious drawing of map, section, or diagram. Comparatively few authors can command the services of skilled draftsmen or have themselves the requisite training to produce satisfactory line drawings. Yet the desirability of greatly increasing the proportion of such illustration in the thousands of scientific articles published each year is manifest. That clearness, precision, and conciseness in the exposition of a theme are generally enhanced by the use of abundant, appropriate diagrams is as evident as that the blackboard is the constant friend of the teacher of any branch of natural history or philosophy; the printed page needs its blackboard.

Ideally, the author should himself be able to make the original drawing quickly, neatly and artistically. The usual execution of drawing with the pen is, to the average author, discouragingly slow and expensive, not always neat, and still less often artistic. The following note relates to some experiments made to increase rapidity and neatness in the production of line


A B C D E F G H I J K L M N O P Q R S T
U V W X Y Z a b c d e f g h i j k l m n
o p q r s t u v w x y z 1 2 3 4 5 6 7 8
9 0
Locality marks
Triangulation stations etc
Samples of general purpose legends

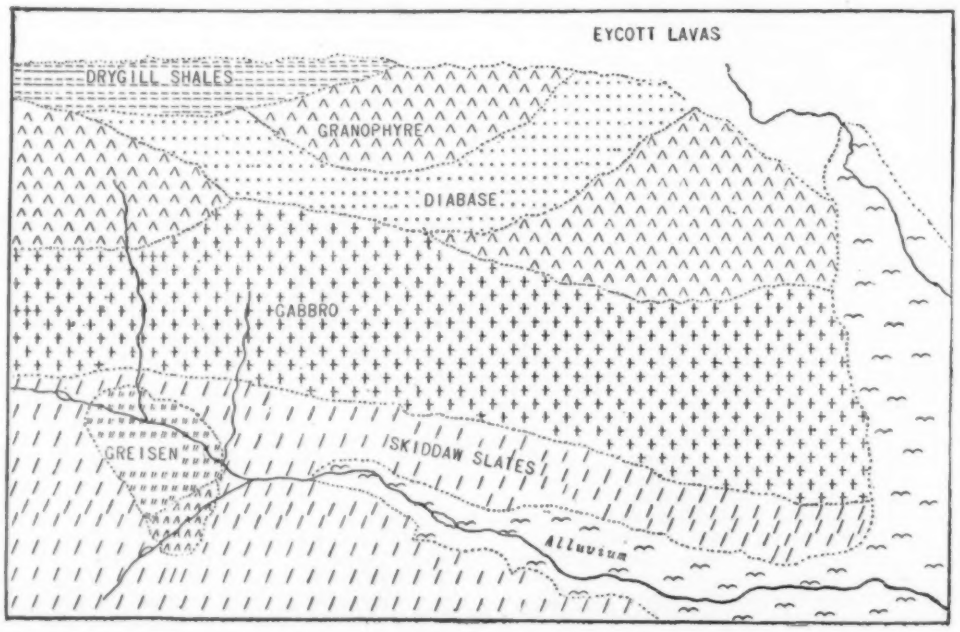
drawings by the use of a machine. At the outset the experiments were, for obvious reasons, planned without any idea of rivaling the artistic work of the pen in a skilled hand. The aim has been to secure economy of time in execution and clear-cut precision of legend for the drawing. In both these respects enough success has been attained to warrant the recommendation of the machine method to geologists, geographers, and others who desire to prepare useful text illustrations at a minimum cost of labor. Some essays of the kind were made and published in the Bulletin of the Museum of Comparative Zoology at Harvard College, vol. xxxviii., 1902, Pls. 11, 12, and 13, in the Amer. Jour. of Science, August, 1903, pp. 118 and 120, and in the American Geologist, August, 1903, p. 66. The machine there used was an ordinary Underwood typewriter fitted with a black record silk ribbon. Recently the Hammond Typewriter Company, of New York, has constructed, from the writer's specifications, a typewriter provided with a carbon ribbon and with ninety special characters designed for the preparation of line drawings to accompany geological and geographical papers. The same machine can be similarly used for statistical, engineering, and other diagrams of a more or less mechanical and simple composition. Of course, this method should not wholly replace the use of the pen even, for example, in the differentiation of areas in a geological map or section. The ultra mechanical look of the typewritten legend can often be pleasingly relieved by the easily and quickly applied cross-hatchings, etc., made with an ordinary drawing pen. In complex diagrams free-hand work may generally be expected to supplement the work of the machine. The subject of each diagram should thus be studied with the end of securing suitable contrasts of legend along with the maximum economy of pen work; yet some pen work is almost always necessary.

The typewriter has its most general application in lettering, that most difficult element in line drawings. The particular machine made by the Hammond Company has the advantage of making it possible to employ a great range of type styles. Using the carbon ribbon, the writer has found that any one of the one hundred and twenty-five shuttles made for the machine (each shuttle bearing ninety characters and including the lettering for one of twenty-six different languages), will give an impression suitable for photographic reproduction. Each shuttle can be placed in the machine ready for work in a few seconds. The shuttles now on the market cost $2.50 each and any new character can be supplied by the company at the cost of fifty cents. The ordinary Hammond machine furnished with a back-spacing key can be used for manuscript diagrams up to about eight inches in diameter, but the machine No. 6, fitted with a sixteen-inch roll, permits of the preparation of diagrams fourteen inches in diameter. The usual silk ribbon gives a "woolly" line and is far less satisfactory than the carbon ribbon. A highly calendered and high grade linen paper of medium to heavy weight, or a thin Bristol board may be recommended. Often more than one impression of the key is necessary to obtain the required depth of tint for photography; such repeated impressions can be made at great speed by employing the back-spacing key. Care must be taken not to smudge the carbon of the completed printing.

The accompanying cuts serve to show something of the method as applied to geological diagrams. The diagram of alphabets and legends has been reduced to three-fourths of its original diameters. The legends are intended to represent a few examples of those possible with the machine. They can be indefinitely increased in number and varied in design by the engraving of new characters on the shuttle and by using various permutations and combinations of the existing characters. The map is reduced to two thirds of its original diameters. It was copied from Harker's sketch map of the Carrock Fell District, published in the Quarterly Journal of the Geological Society of London, vol. 51, 1895, Pl. iv. Here the geological formations could have been yet more clearly differentiated by cross-hatching with the ruling pen for one of them, but this particular drawing was made to illustrate the neatness and clearness of the machine-made production rather than to illustrate an ideal diagram. So far as the typewritten part of the "drawings" is concerned, the use of the machine in preparing these illustrations represents a saving of from seventy-five to ninety per cent of the time required by a draftsman to duplicate the "drawing."—Science.

EUROPIUM.

SOME further light is thrown upon the new element europium by the researches of G. Urbani, of Paris. The author and M. Lacombe extracted europium from monazite earths. Six consecutive fractions of this earth showed constant qualities, having the same atomic weight, absorption spectra, spark spectra, etc. Since then he extracts the same element from xenotime and pitchblende. The earth which is prepared from very different minerals shows the constant properties which serve in general to characterize a definite element. The author commenced the study of the cath-



ceric phosphorescence which europium furnishes by dilution in the oxides at different degrees, and finds the following results. Pure oxide of europium is not phosphorescent under the present conditions of working. When diluted in chalk in the proportion of 1 per cent, the different samples of the earth gave the same red phosphorescence, without showing any difference in the spectra. The successive fractional products comprised between pure europium and pure gadolinum are phosphorescent without using any diluting substance. The oxide of europium acts here as the exciter and the gadolinum oxide as the diluting body. Starting from europium the fractional products are red, then pink, and finally come to white when we reach gadolinum; in the latter case the brightness is lessened. The spectra of these consecutive products becomes gradually modified exactly as if europium were a mixture of at least two phosphorescent earths. The author seeks to find whether the same spectral variations will not be produced when we examine europium in different states of dilution. He finds that the same sample of pure europium diluted in increasing proportions of pure gadolinum, will allow of reproducing all the above spectral phenomena. The specter which is observed at first in earths having a large proportion of europium shows only the bands in the red and the yellow. The most characteristic are 631, 613.5, 611 which is the strongest, and 587.5. The specter which then appears and grows stronger as the other weakens has a large number of rays from 594.8 to 400. The principal rays are for the yellow 594.8, 592.0, 581.5; for the green 537 and 533; in the blue, 489, 479.5, 473.8 and 472; in the indigo 468, 465 and 451; in the violet 436, 428.7, and 426.5. In the ultra-violet we find 421, 417, 416.2, 414.1, 412.0 and 403.7. A proportion of 1—100,000 of europium gives a marked phosphorescence to gadolinum, and the second specter is much brighter than the first. With 0.4 per cent of the former we have both spectra equally well-marked. Europium diluted in chalk or alumina gives analogous spectral variations. The above experiments show that in spite of the appearance of the spectra observed in the intermediate terms of the separation of europium and gadolinum, the former element has not necessarily undergone a decomposition. However, further researches are indispensable in order to decide whether europium is to be considered as a mixture of two distinct phosphorescent elements or whether the differences which the europium specter shows at different degrees of dilution should be imputed to a cause which is purely physical and independent of all complexity as to composition.

AN EXTENSIBLE PULLEY.

THE extensible pulley illustrated herewith is capable of rendering very great services for the reason that it permits of dispensing with changes of speed, which constitute a complication, despite the ingenuity of the existing systems. This is because the ratio of velocity between the driving and receiving shafts being naturally fixed, it is necessary to have recourse normally to gearings or several pairs of pulleys to cause it to vary. With a single pair of pulleys we obtain a variation of the ratio of the velocities, one of the pulleys increasing in diameter while the other decreases to the same degree. It was to supply the want of such a device that the Fouillaron expansible pulley (which is applied especially to automobiles), was invented, and also the Roger du Montais apparatus. The Delagneaux pulley, which we illustrate, is based somewhat on the same principle as the last mentioned apparatus. There are used in this what are called "lazy tongs," an arrangement formed of strips jointed to one another so as to form a series of lozenges. Napkin rings and flower pot covers are manufactured on this same principle. In the latter case the "tongs" are arranged vertically and even in a somewhat conical manner. In napkin rings they may be arranged in the same way, or else be placed flat with respect to the axis of the cylinder formed by the rolled napkin.

The expansible rim of the Delagneaux pulley consists of two jointed rings made of such "tongs" and placed edgeways in planes at right angles with the axis of the pulley. The summits of the lozenges are situated upon concentric circumferences, and in pairs upon the same radius. The intermediate assemblages of the levers can be made according to a circumference which divides into two equal parts the large diagonals of the lozenges, which are themselves arranged according to the radius in which the summits thereof are situated. The three axes of a same lever are not in a straight line, and the exterior halves are larger than the interior ones. These are geometrical conditions which are easily satisfied, and which permit the respective arcs of the circumferences determined by the points to remain constantly proportional to their respective radii.

Of course, the plates, if we may so call them, have a form and size dependent on the diametral ratio and on the power to be obtained. In order that the belt to be driven may find an adequate surface, each external summit of the lozenge carries a slightly curved metallic plate, of suitable length, arranged parallel with the axis of the pulley, and the series of these plates forms what is really the pulley. The plates of this pulley the spaced apart so much more in proportion as the pulley is more distended, as its diameter is greater and the lozenges are more flattened, and their summits are more distant from each other. But such an arrangement can have only the advantage of increasing the adhesion of the belt to the pulley. The belt, by the way, may be of any nature whatever. It is unnecessary to say that the transverse plates forming the pulley can be easily cut out of steel plate as long as they do not exceed certain dimensions; otherwise recourse may be had to molded pieces. The wear is hardly perceptible, for this kind of chain works especially by traction. It is easily repaired or replaced.

As regards the expansion of this pulley, different means are possible. At the outset M. Delagneaux had recourse to exterior arms jointed at their extremity to rings sliding upon the pulley shaft. When the rings were made to approach, the arms straightened out and

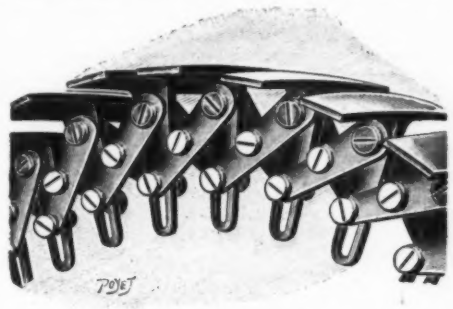


FIG. 1.—DETAILS OF THE EXPANSIBLE PULLEY.

distended the pulley. At present, the arrangement, which at first sight recalls the Fouillaron pulley, comprises a movable cone with male arms which enters a fixed cone with female arms. The extensible pulley is mounted at the intersection of these two cones, which are placed summit to summit.

A set of pulleys of this kind greatly simplifies the shifting and driving gear in a machine shop, since it does away with fast and idle pulleys, cones with steps, etc. A lever permits of establishing or breaking the correlation between the two pulleys, and consequently of starting or stopping the mechanism controlled by the receiving pulley. During the work, a spiral spring gives a constant automatic tension to the belt. It is possible to obtain any degree of velocity; and, in an inoperative position, the belt is slackened by the reduction of the two pulleys to their small diameter without the workman having to touch it.—Translated from La Nature for the SCIENTIFIC AMERICAN SUPPLEMENT.

ON A TOUR OF THE SHOPS.

SHOP methods have changed greatly in recent years, and school and college trained mechanics are making their influence felt more and more, but the old-time mechanic, with a mind accustomed to dealing with emergencies and able to turn his hand to almost anything, still survives in many of the shops. His training is very different from the younger generation. He knows less about mathematics and accurate drawing to scale, but his intimate knowledge of the practical working of machinery makes him an invaluable factor in every shop. He knows his machinery by heart, and any heart throb that is not natural attracts his attention. He can usually tell by the "feel" what ails a complaining machine. He knows every "cranky" engine or machine in the shop, and he understands

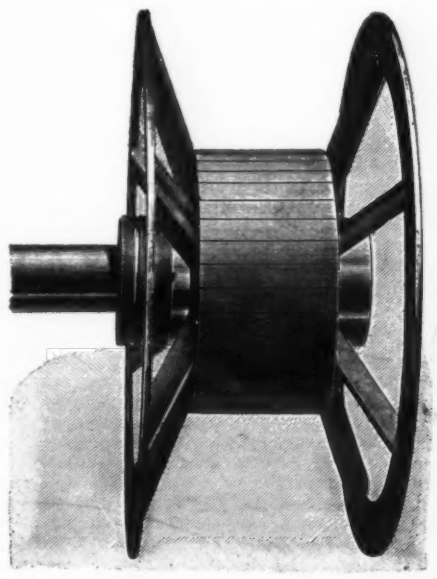


FIG. 2.—GENERAL VIEW OF THE DELAGNEAUX PULLEY.

how to favor each one to get the greatest amount of work out of it.

But it is in the repairing of machinery that the old-time shop hand is at his best. Here he is in his element. He was brought up in the school which made every machine shop an independent entity. It was impossible in those early days to order duplicates of machinery by telegraph, and expect them to be delivered within twenty-four hours. Consequently, every shop had its resourceful mechanics, who were capable of repairing any machine so that it could continue its work for several weeks until the new parts could be forged or made in some distant factory. It was this very training which made the old-time mechanics such men of inventive genius. If an engine rod broke or a steam box fractured, the mechanic of the shop could repair it so that work would not have to be shut down for long. The breaking of a huge flywheel only meant temporary delay. An old-time shop mechanic recently told me how he had rigged up a wooden flywheel within twenty-four hours after an iron one had broken, and the temporary one worked successfully until the order for a permanent wheel could be filled.

In the modern, up-to-date shop, where nearly every part of the machinery is supplied in duplicate, so that the breaking of any piece merely causes a little shut-down, the tendency has in recent years been to depend less and less upon the old-time all-round, ingenious shop mechanic. The feeling has grown that the human element will be more and more eliminated from the shop as an important skilled factor. It is the machinery which holds sway, and which does the work, and the man who operates it merely holds an inferior position. Yet there are some shops which take the opposite view of this. A visit to one of them a short time ago revealed quite a unique condition of affairs. It was filled with old-time mechanics and shop workers. Very few of the new school were present. Was this an accident or intentional?

"Partly both," replied the superintendent. "I brought most of these men back with me from Mexico, and I shall keep them as long as they care to stay here. I went down there five years ago to install and run for a year a new railway shop in the city of Mexico. I knew I could not depend upon native labor, and so I selected my men in this country and took them with me. I was warned before I left that there was no possible way of getting duplicate parts of machinery in that part of the country inside of a month or two. It all had to be shipped by train from this country. Therefore it was quite essential that I should take with me men mentally equipped to tackle emergency jobs. I chose the old-time practical shop men, those who had been accustomed to the old methods of independent work. I was not disappointed. Down there we met some pretty ugly propositions in mechanics, for the railroad company was poorly equipped with repairing machinery. But we surmounted every difficulty. Every time we ran up against a hard thing, we held a council of war. Every man had a right to state his way of making the repairs, and then we selected from the list the most serviceable. Well, it would have surprised you to see some of the ingenious and practical methods proposed by those old mechanics. They could have given your new school-trained shop man a mile ahead start and beat him out. They gave me pointers which I haven't exhausted to-day. I shall continue working on them for years to come. When we got through with that Mexican job, I brought the men home, and I consider we have the best set of mechanics in any shop of the country. There is a feeling of responsibility among the men which is difficult to get in a mixed lot.

"We still hold our meetings to consider the best method of proceeding when anything happens, and the men put in their solutions for the trouble just as they did down in Mexico. At these meetings we get an exchange of views that is worth a good deal. For instance, the other day we found it necessary to make repairs to a warped bed on which some heavy machinery stood. The question was raised as to whether we should have a new bed on new foundations, repair the old, or design something of our own. Here is the proposition one of the oldest mechanics and engineers in the shop made: Tear up the old bed and foundation; cut down to hard pan in the soil in a space one foot wider than that required for the machine, and then build up a firm foundation of coarse stones laid in cement, and finish off the top with good concrete. This latter is brought up a few inches below the level for the bed. While the top course of concrete is soft, heavy three-inch oak plank is buried in it, the ends and sides being completely covered with the cement. When the cement hardens, the plank is firmly imbedded. On top of this wooden bed fastened into the cement oak planks are screwed firmly, and to the wooden floor thus laid directly on and into the concrete foundations the legs of the machine are screwed. A perfectly level floor bed is thus obtained, and there is absolutely no vibration. When the floor gets warped or worn, the top planks can be taken up and new ones put down.

"This suggestion proved so novel and promising that we have made an experiment with it. We shall lay it under a heavy engine lathe, and if it proves all that is desired, we may repeat it under other machines. Like most shops, we have experienced a good deal of trouble with beds for heavy machinery. They get warped or uneven in a short time where the weight of the machinery is unevenly distributed, and particularly where the pounding of the machinery is over one part. The question of building absolutely firm beds which will neither warp nor drop on one end is a nice one in many shops. The constant raising of ends and putting chips under them to secure a perfect level can hardly be called good workmanship, and yet in many shops this is just what is being done. Beds which will not warp or change the level are greatly to be desired."

It is a fact that in a good many machine, repair, and construction shops, ideas and suggestions are made by the men which are not always received in the right spirit. The tendency to consider a poor mechanic of little account, except in his special line of work, is fatal to the highest efficiency of any single crew of men. Superintendents, foremen, and master mechanics are often so jealous of their own positions, that they resent any suggestions from those below

them. Yet it has been the writer's fortune to run up against a number of cases where the most useful inventions in use in the shops came through the suggestions of the men who held inferior positions. They had the knack of seeing how things should be done to save time and labor, and their practical knowledge made their suggestions invaluable.

In a good many shops where devices of a novel nature are in use no drawings whatever exist, or if crude ones were made they have been destroyed. In many cases the men had the designs made according to the suggestions of subordinate mechanics. Frequently such crude devices have saved thousands of dollars to the shops, either through increasing the output or decreasing cost of production. As these devices are not patented they are not put on the market, and other shops are not benefited thereby. One shop is not inclined to throw open its secrets to another, but where devices are not considered important enough to patent, little harm can be done by an exchange of visits between master mechanics and foremen of shops. New descriptions of shop methods and labor-saving devices would furnish a great amount of data for shop foremen and superintendents to study, and in the aggregate they would greatly raise the general standard of appreciation of the subordinates who work in the various machine, repair, and construction shops of the country.

EXPERIMENTAL EVOLUTION.

By Dr. Hugo De Vries.

What is that in the egg which enables it to develop all the qualities of the bird? Something must be there, and we may even assume that all the separate qualities displayed by the bird have their representatives in the egg.

Now, if it were only possible to get at these representative particles within the egg, what changes might not be effected in the development of the bird! To take a very simple example, the peacock has a white variety, lacking the bright colors of the feathers. If in the egg of an ordinary peacock we could seize upon the representative particles of the color and impede their development, perhaps we would succeed in reproducing the white variety at once and quite artificially.

Obviously this is the heart of the matter, for if once the principle should be discovered to dislocate such a representative, we might apply it to numerous other instances. A white peacock would be no novelty and no gain, but we would be able to make white varieties of other birds and other animals, and perhaps even of the bright-colored flowers, which until now have resisted all endeavors of breeders in this line of work.

Methods of attacking this problem are not at all failing. We might try to kill some of the representative particles in the egg, or to stun them, or to injure them in ever so slight a measure, so as only to retard their development. More than one starting point for such an attempt is at hand. Engelmann has shown us a method of lighting and heating small parts of a living cell. He uses the focal point of a glass lens, which he directs upon the cell while lying under the microscope. If now a very small part is overheated and thereby killed, the remainder of the cell is seen to be still living and apparently uninjured. By refining this method some of the most sensible representative particles might perhaps be killed without too much injury to the others.

Other agencies might be tried. The finest and most effective methods offered by allied sciences must be applied. If one fails, another may succeed.

The process of the evolution of animals and plants must be attacked by direct experiment. This evolution, however, has a long history, covering many millions of years. Its historical part, of course, is not accessible to experimental work. From its innermost nature it must be studied according to historical and comparative methods. In laboratory work we may simply pass it by.

After eliminating this great mass of detail concerning the pedigree of the animal and vegetable kingdom, two points remain, which present themselves for experimental study. These are the beginning and the end. Obviously the real end is not yet reached. Evolution is going steadily on even now. In the same way we may assume that the beginning is not yet finished. The laws that ruled the material world some twenty or thirty millions of years ago must have been the same that are still ruling it in our days. Circumstances may have changed, but it is not very probable that those which permitted life at the beginning and those which have made it possible during the long geological ages should have been widely different. On the contrary, it seems only natural to assume that new life may nowadays originate as well as in former times. It is only a question of where we are to look for it.

On this very difficult point I like to be guided by the genial conceptions of Brooks. In his "Foundations of Zoology" he depicts the primeval seas and their living population. All life must have been limited at those early periods to the high sea; all organisms were floating amid the ways, going only to a depth of some few meters. Here the main lines of the animal and vegetable pedigree must have been produced, starting the great divisions of both kingdoms. The only exceptions are offered by the flowering plants and the vertebrate animals, which seem to have originated on the shores or perhaps on the land itself. As long as all life was in this floating condition, evolution proceeded rapidly and broadened out. Then came a period when, as Brooks says, the organic world made the discovery of the possibility of living on the bottom of the sea, feeding on the sinking remains of the floating world. This great change was the starting point for numerous adaptations and for the evolution of a richness of forms and structures, but without the previous progress in the production of many really new divisions.

It is a very attractive picture. For us it points to the probability that the very first organisms must have been inhabitants of the upper sea, floating on the waves, or they must have been members of the plankton, as it is now called. Thence the conclusions that it is within the plankton that new creations are to be sought for. If really they are still occurring in our days, it must be the high sea that conceals them. Obviously these first organisms must have had the lowest possible degree of organization. They were not cells, they cannot have had any differentiation. They must have consisted of a uniform jelly, with only the capacity of increasing their mass. If such a jelly could be detected, what possibilities would not be opened to experiments on evolution! The chance may seem very small, but then, before Rontgen and Curie there was no chance at all of discovering X-rays and radio-activity. The plankton has to become one of the main points of interest for all who care for experimental evolution.

The other end of the evolutionary development is the evolution that is still now going on. Here we are on surer ground, though even here the methods and the starting points have yet to be discovered.

Two main lines have to be followed. One is the direct study of variability; the other relates to the dependency of this variability on the outer conditions of life. The first line uses the statistical method, while the second relies chiefly on experiment. Both have to be cultivated on botanical as well as on zoölogical ground.

The experience of agriculturists and horticulturists has long since established the fact that new forms of animals and plants from time to time arise. How they originate is another question, which it is not the task of practice, but of science, to answer. The fact, however, is undeniable, and all observations point to sudden changes or so-called sports as the first beginning. Especially in the dominion of horticulture Korshinsky has shown by an ample critical survey of the historical evidence, that sudden sports are the prevailing rule and probably even the exclusive manner of originating new varieties.

Such considerations have led to the conviction that what occurs in horticulture must also occur in the experimental garden. If the conditions are the same, why should not the phenomena be the same, too? If mutations are rare in horticulture, the experimenter has only to arrange his work so as to be able to detect rare occurrences in his cultures, too. In doing this I have succeeded in observing mutations quite analogous to the horticultural instances, and collecting all the evidence concerning their ancestry and their descendants as well as concerning the mode of their appearance.

Moreover, I have had the good fortune of discovering a wild plant which is even yet in a condition of mutability. Yearly it is observed to produce new species. It is the large-flowered evening primrose, which bears the name of Lamarck, the founder of the theory of evolution. It clearly shows how new species arise from an old stock, not by continuous and slow changes, but suddenly. The stock itself is not altered by the process nor even noticeably diminished. The new species which it produces arise on all sides. Some of them are in a higher, others in a lesser degree fit for their life conditions; some persist during years, while others disappear nearly as soon as they arise.

This instance of experimental mutation is found largely to agree with the experience of breeders, especially in horticulture, and likewise with the conclusions that have been drawn from comparative studies. The assumption that those species and genera which now consist of large groups of closely allied forms have originated in the same way seems quite undeniable; and as soon as the validity of this generalization is granted for these cases it will have to be considered of general, if not universal, bearing.

Two main lines have to be distinguished: the study of the phenomenon itself and that of its causes. Mutations, of course, cannot be assumed to be a special feature of the evening primroses. They must occur elsewhere, too, and these must be sought. The Oenothera was one of a lot of nearly a hundred species tested as to their constancy; it proved to be the only changeable form among them. By testing a hundred other species or other strains of the same forms it seems probable that one or two new instances of mutability may be detected. The best way is to try the wild species of the nearest environments or of other regions with a corresponding climate, since large numbers of seedlings have to be examined. One or two novelties among thousands of individuals of the common type are not easily found, especially when the differences are slight and new, and thereby apt to be overlooked. Much care is to be given, and the trials have to be repeated with the same species in succeeding years. With increasing experience the chances of discerning the small indications of novelties are rapidly augmented. No differentiating marks, however slight, should be considered as insignificant. All aberrant individuals should be planted separately and protected with all the care required to insure the fullest development. Many of them afterward prove to be only fluctuating variants or to have deceived the experimenter. They are simply discarded. It is quite sufficient if some remain and prove to be mutants. As soon as in this manner a mutable strain will be discovered the greater part of the other species may be excluded, although the search for new mutable species should never be wholly neglected. Each year some new forms should be taken into culture, in order to have sufficient chances of gradually increasing the evidence concerning the occurrence of mutability in nature.

The chief object of this inquiry, however, must be the study of the mutable strain itself. Some of its seeds yield new species, while others are more conservative. Thence the question, Which seeds mutate and by which causes are they elected to do so? The location of the mutating seeds within the fruit, the position of the preferred fruits on the spikes, the influence of the individual strength of the sundry branches and many other points have to be investigated. Further, it is probable that the degree of mutability, or, in other words, the yield of mutating seeds, is more or less dependent on the outer life-conditions. Thence the necessity of studying the influence of culture in general, of light and heat, of soil and water, and last, but not least, of manure. Extreme combinations of these factors should be tried to see whether perhaps they may give extreme results.

Underlying all and directing all the efforts should be the hope of obtaining such a knowledge of the phenomenon as would enable us to take the whole guidance of it into our own hands.

SOME NEW IDEAS ABOUT FOOD.

The important question of the physiology of nutrition is fully considered by Dr. Frank Billings in a recent issue of the Journal of the American Medical Association. It is especially important to the physician, for without a clear idea of the subject he cannot prescribe a proper dietary for the well or sick, nor can he clearly understand the result from malnutrition.

According to the author, it is the belief of the layman and of many physicians, too, that the chief nutrition of food consists of the proteids, and that meat, especially, is looked upon as the food which affords strength and sustained effort. Among Europeans and Americans especially meat eating is very prevalent, chiefly for the reasons given above. Besides this, the palate is pleasantly excited by rich animal foods, and in consequence a larger amount is taken. It is too common a belief that the well-nourished body is the most healthy and best able to resist disease, and that a large fat deposit in the tissue is an evidence of good general nutrition.

"Our food," says the doctor, "is made up of proteids, fats, and carbohydrates. The proteid or albumen, both animal and vegetable, is the tissue builder. Relatively, a larger amount of proteid is required for the growing individual, pound for pound, than for the adult. The fats and carbohydrates (sugars and starches) comprise the fuel of the body, and supply the necessary heat and keep the machinery going."

Dr. Billings cites the standard of Carl Voit, of Munich. Voit considers that a normal man of an average body weight of 150 to 165 pounds, doing a moderate amount of work, requires daily 118 grammes of proteid, 55 grammes of fat, and 500 grammes of carbohydrates. This gives a total food value of about 3,000 calories, and will maintain the body in a good physical condition.

The fate of the elements, when taken into the body, we are told, is as follows: "Fats and carbohydrates, when oxidized in the body, are ultimately burned to simple gaseous products, that is, carbonic acid and water. Consequently, the waste from these food products is quickly thrown out of the body without resulting harm to any of the tissues. If such products are taken in excess, the harm which results will be chiefly in the deposits of fats in an undesirable amount, which would render the body gross and unwieldy. A too large amount taken is very apt to clog the alimentary canal, overfatigue the digestive organs, and may undergo abnormal fermentation.

"The waste products of proteid foods, when assimilated, consist of crystalline nitrogenous products, which ultimately pass out of the body, chiefly through the kidneys. Before their elimination from the body these crystalline elements, which are in some instances toxins, float about through the body, and may exercise a deleterious influence on the organism, either general or local. The literature is full of theories on the diseases due to many of these crystalline products, chiefly uric acid, urea, etc. All who are acquainted with these facts have recognized the importance of restricting the formation of the deleterious crystalline waste products by limiting as far as possible the amount of proteids taken into the body."

Until recently it has been the belief that the nitrogenous equilibrium of the body could not be maintained on a less amount of proteids than that given in the standard diet of Voit and others, but of late far-reaching experiments have been made on the physiology of nutrition and of metabolism of the body, which practically revolutionize the ideas held by most physiologists.

Reference is made to experiments conducted by Prof. R. H. Chittenden, of Yale University, that demonstrated conclusively that men from all classes of individuals, in regard to mental and physical work, could meet all ordinary requirements of mental and physical labor with a high efficiency on an intake of proteid food far below that of the standard diets. It was found, too, that in the reduction of the proteid it was not necessary for these individuals to increase very much, if at all, the amount of fats and carbohydrates to maintain themselves in good condition.

Attention is called to the evils of insufficient mastication which entails an enormously increased work on the digestive organs.

"An excess of proteid in the food," the doctor tells

us, "is not stored up in the body as such, for the actual need of nitrogen is very small, as it is limited to the actual building up of the cell bioplasm. It is not necessary to store it in the body, because an excess of nitrogen is always furnished with the food. A larger nitrogen intake than is necessary to meet the needs of endogenous metabolism will lead only to an increase in the elimination of urea."

It is stated that the organism, at any time, may be made to store up fats and carbohydrates, if an excess over the requirements is taken. An excess, however, may overburden the digestive organs and cause abnormal fermentation. Too large a deposit of fat may render the body unwieldy, and may infiltrate and physiologically embarrass the muscles and viscera.

The author draws the conclusion that the so-called standard diets are unnecessarily rich in proteids. "It is necessary to supply protein in the food," says he, "in sufficient amount to provide liberally for the endogenous or tissue metabolism and to maintain a reserve protein in solution. If the blood is in need of tissue builders, the organism can rapidly assimilate large amounts of nitrogenous food. This is clearly shown in emaciated conditions following fevers, surgical operations, etc., for during convalescence there is often a ravenous appetite and a rapid increase in weight and strength with a corresponding retention of nitrogen. . . . The growing individual and the emaciated convalescent only can utilize a large nitrogen intake and retain it. The difference in the dietary of grown normal individuals will consist mainly in the fuel foods—the fats and carbohydrates."

Dr. Billings contends that the achievements of the Japanese on a diet chiefly carbohydrate is sufficient proof that a high efficiency, both mental and physical, may be maintained on a low proteid and full fuel diet.

The question whether a large proteid diet is not only unnecessary but also detrimental is answered by the doctor in the affirmative. "The continued excessive use of protein," says he, "may lead in time to the accumulation of a larger amount of reserve protein than the organism can maintain in the fluid media. The continuous unnecessary supply of unorganized reserve material may weaken one or all of the living tissues.

"We are creatures of habit. With palates craving for new sensations, and the prevalent belief that hearty eating promotes health and strength, it is no wonder that we eat too much. It is proper, too, that the pleasure of the palate should be gratified. The pleasure which eating affords promotes digestion. Bolting does not permit proper enjoyment of food. Thorough mastication undoubtedly makes the palate more discriminating, and serves as a check to overindulgence."

CRYSTALS.

P. GAUBERT, of Paris, has made a number of experiments upon the artificial coloration of crystals. The influence which certain substances in solution in the mother-liquor have upon the forms of crystals which come from the latter has been recognized for a long time past and has been the object of numerous researches. However, the writers have generally been limited to observing the variations in the form of the crystals due to the presence of foreign bodies, without seeking for the cause. Only one attempt to do so has been made by M. Berent. We have taken up these researches and use different coloring matters which are soluble in the mother-liquor. The experiments were made with nitrate of lead, urea, etc., and afforded some unexpected results. The crystals of these substances can in the course of their growth absorb a certain quantity of methylene blue, and in this case their coloration is accompanied by changes in their crystalline forms. Besides, in general the fixation of the coloring matter is produced unequally according to the different crystal faces and the sides which absorb the most are also found to take the greatest development. A new example of these related properties is furnished by *phtalic acid*, $C_6H_4(CO_2H)_2$, which is remarkable for the facility with which it allows coloring matter to penetrate into the crystal. M. O. Lehmann has already colored crystals of this substance artifically, but we also show that the introduction of the coloring matter brings about certain changes in the form of this substance, as well as for some other crystalline bodies we observed. The crystals of phtalic acid are monoclinic and have a well-marked cleavage in a certain direction. The form of crystal which is obtained from a distilled water solution is a flat and elongated crystal. Organic coloring matter added to the solution always produces a crystal which is different from the normal type. These forms may be reduced to three general types. The first of these is formed with methylene blue. The crystals are much thinner than the former and present several crystallographic modifications of their different faces. By the use of fuchsine, rosaniline, etc., we obtain somewhat similar forms. The first of these substances gives a thicker crystal than the others. The second type is furnished by malachite green. Here the crystals are elongated on another axis and still remain flat. They are always very small and only reach a few millimeters, while in the presence of methylene blue they exceed 2 centimeters (0.8 inch) in length. Methyl green and methyl violet give modifications of the same type. With diphenylamine blue we find the third type. The crystals are always small, but are grouped together in great number so that the group has a crystalline aspect. The quantity of foreign matter which passes into the crystal is small. For the maximum quantity we find, methyl violet, 1-200; methylene blue, 1-176; safranine, 1-180, etc., so that it has no perceptible influence upon the density or the melting point of the crystals, nor the value of the angles. These conclusions apply to different bodies, and allow us to explain some peculiarities which are shown by many of the minerals we find in nature.

TRADE NOTES AND FORMULÆ.

A New Method of Preserving Fish-Nets, Sails, Etc.—A new method of preserving fish-nets, sails, etc. (and probably ropes) suggested by Bull of Bergen, has been given a thorough test in the Station de Recherches Maritimes at Ostend, and the results have been so good that we here give a brief description of it.

The nets are put into a bath consisting of 150 parts by weight of dyer's oak extract, and 4,000 or 4,500 parts of water for every 1,000 parts, by weight of net, left here at least forty-eight hours, and dried in the air. They are then immersed in a solution consisting of 15 parts of potassium bichromate and 20 parts of copper sulphate in 4,000 to 6,000 parts of water for each 1,000 parts by weight of net, left here two or three hours, rinsed in clear water and dried.

The dyer's oak extract is taken from the bark of an American variety of the oak (*Quercus nigra digitata s. trifida*, or *Quercus tinctoria*), and was obtained in the case of the above-mentioned tests from the firm of Julius Nathan in Hamburg, at the price of 0.72 to 0.80 franc per kilogramme (2.20 pounds). In order to get the full benefit of the astringent principle contained in the extract, the water should previously be heated, and the extract stirred in gradually. Iron utensils should not be used. Copper kettles and a wooden stirrer are best. The best way to heat the water is by forcing in steam. If it is heated over an open fire the fluid must be constantly stirred. When the solution is complete, the nets are laid in evenly and covered with a trellis-sieve upon which a heavy weight is placed, and the kettle is covered. Rapid cooling of the bath is to be avoided. The fact should be noted that nets of Manila hemp are less easily saturated than others, and should remain in this bath from two to five days. The fluid decomposes quickly, and cannot be kept for further use longer than two or three days. For the second bath the potassium bichromate and the copper sulphate are to be dissolved separately in a few quarts of boiling water, and the solution diluted with the necessary quantity of cold water. A porcelain or enameled vessel is best for this purpose. The whole process can be repeated several times, if necessary for the more perfect saturation of the nets, but once is usually enough. The cost of this preserving agent is 12 or 14 pfennigs (three or four cents) for each kilogramme (2.20 pounds) of net, and in view of the excellent results of the Ostend experiments, it would seem well to give the method a general trial.—Allgemeine Fischeres Zeitung.

Dull Black Varnish for Brush Boards.—A very fine dull black finish for brush backs is made as follows:

The wood is first very carefully polished with fine sand-paper until perfectly smooth, care being taken to remove any unevenness of the surface left from planing, which would affect the tone of the varnish by causing light to be differently reflected. After polishing and wiping, the wood is colored black with a wood stain consisting of one part, by weight, of spirit-soluble nigrosin and 75 parts of wood-alcohol. This is prepared by putting the nigrosin into the wood-alcohol, in a glass flask, and shaking until dissolved. It is applied with a brush or sponge. After drying, which takes an hour or two, there is a second polishing with fine sandpaper, and a second application of the stain. A thorough drying completes the preparation of the wood and the varnish can now be put on. For this purpose a hair brush, from 6 to 10 centimeters wide, mounted in sheet metal, is used. The brush should not be passed back and forth, but the application must be in one stroke, making a moderately deep and even coating. After drying at a moderate temperature (77 deg. F.) in a well-ventilated room, a second coat is put on, and sometimes, if the wood is very porous, a third. In most cases, however, two coats are sufficient to give the desired dull black surface. Five or six hours should be allowed for drying between the applications. The varnish is made by soaking 150 parts, by weight, of celluloid in 300 parts of absolute alcohol, mixing with this 3,375 parts of amyl acetate, and letting the whole stand for several days; the mixture is then strained, 20 parts of alcohol-soluble nigrosin are then dissolved in it by shaking, and 75 parts of lampblack, ground with previously prepared varnish, in a color-grinding machine, are added and well shaken in. —Neueste Erfindungen und Erfahrungen.

Technical Uses of the Wood of Fruit Trees.—The wood of our fruit trees is by no means of as little value as supposed by many farmers. Trees are occasionally rejected from every orchard, on account of age, disease, or unfruitfulness, and attention should be called to the uses to which the wood may be put.

It is universally known that walnut finds extensive use in fine cabinet work, and commands a good price. It has recently been used in large quantities for making gun-stocks.

Cherry wood is also used in furniture, and gives imitations of mahogany, taking a beautiful color when polished.

Apple-tree wood is remarkably well adapted to turner's work, and is in demand for making cog-wheels, on account of its great strength and durability. The cogs of wooden mill-wheels are often made of apple wood. It is also extensively used for fruit presses, where it proves very durable.

Plum-tree wood is valuable for making spigots, wooden molds, and the handles of kitchen knives.

Quince and peach tree woods are highly valued for fine furniture and technical implements. The dark color and beautiful grain of peach wood make it much sought after.

Pear-tree wood is utilized especially for making rulers and the shafts of lqoms, as it does not warp or bend when exposed to the air. Of late it has been used in the place of beech wood for cuts, confectioners' molds, etc. It makes excellent imitations of ebony.

It can be seen from the foregoing that the different kinds of fruit trees, when not dead or too dry, can be put to much better use than for firewood, for which they are altogether too valuable.—Centralblatt für den Deutschen Holzhandel.

SCIENCE NOTES.

The fire-maker man, is distributed over all lands in a number of races and a still larger number of industrial and social varieties. Until recently all of both Americas was occupied by the Amerind race, and the red men were confined to these continents with their neighboring islands and a small section of adjacent Asia; nearly all of Africa was occupied by the African race, while the black men extended beyond this continent and a few neighboring islands only in a modified or negroid type; and the great Eurasian landmass with its peninsulas and islands was the home of three races—the white men who lead and the yellow men and brown men who follow in that conquest of lower nature through the control of natural forces begun by the making of fire. The physical variations were least in America, more in Africa, most in Eurasia, where the physical break between highest and lowest (albeit spanned by numberless links) is greater than the chasm between the lowest human and the simian.

When Vasco da Gama first passed along the eastern coast of Africa he found that the Arab dhows had charts. Unfortunately none of them has come down to us, or it would have been interesting to compare them with those of the west coast used by the Portuguese at the time, and which were of the crudest description. The sailors of all ages would be the first to make practical maps of the shape of the coasts. Their safety and convenience demanded it, while it is a far easier task to compile such a picture of the earth from successive voyages along coasts over the sea, where average distances from known rates of sailing and courses from the sun and stars can be more accurately ascertained, than from long and generally tortuous land journeys in directions governed by natural features, towns, and so forth. A navigator must be a bit of an astronomer. A landsman to this day seldom knows one star from another. It was the sea charts, or *portolani*, of the Middle Ages that on the revival of learning first gave respectable representations of the shape of the coasts, at a time when the learned monks and others were drawing the most fantastic and absurd pictures, which they called maps.

We may liken the facts on which theories of evolution are based to a confused heap of beads, from which a keen-sighted searcher after truth picks out and strings together a few which happen to catch his eye, as possessing certain resemblances. Until recently, theories of evolution in both realms of nature were partial and discontinuous, and the chains of facts were correspondingly short and disconnected. At length the theory of natural selection, by formulating the cause of the divergence of forms in the organic world from the parental stock, furnished the naturalist with a clue by which he examined the disordered mass of facts before him, and he was thus enabled to go far in deducing order where chaos had ruled before; but the problem of reducing the heap to perfect order will probably baffle the ingenuity of the investigator for ever. So illuminating has been this new idea that, as the whole of nature has gradually been re-examined by its aid, thousands of new facts have been brought to light, and have been strung in due order on the necklace of knowledge. Indeed, the transformation resulting from the new point of view has been so far-reaching as almost to justify the misapprehension of the unscientific as to the date when the doctrines of evolution first originated in the mind of man.

The prevailing classification of mankind during the eighteenth and nineteenth centuries was ethnic, i. e., the peoples of the world were divided into natural groups, defined chiefly by physical characteristics, called races. Partly by reason of limited information concerning the remoter peoples, ethnologists differed somewhat as to the definition and number of the races of mankind; some held that the world's peoples were better divided into twenty or thirty or even into fifty or more races, while others found it more convenient to reduce the number. During the later half of the nineteenth century there was a strong tendency to reduce the races or principal varieties of mankind to five, viz.: (1) the Caucasian or white race, especially characteristic of the central and western portions of the Eurasian continent; (2) the Mongolian or yellow race, inhabiting the eastern-central portion of the same continent; (3) the Malayan or brown race, occupying the southeastern border and islands; (4) the African or black race, inhabiting the continent of Africa; and (5) the Amerind or red race, inhabiting the two continents of America. This classification is

simple and convenient, but open to the objection that certain peoples hardly fit any one of the five classes; the Japanese are neither white nor yellow nor brown, much less red or black, forming, indeed, an ethnologic puzzle, if not a distinct race; while the Blackfellows of Australia, and the Papuans of New Guinea, the tribes of eastern Madagascar, various islanders of Polynesia, the Ainu of northern Japan, certain peoples of southern Eurasia with the Laps and Tartars of the north, the Eskimo of the western hemisphere, and several other peoples depart in greater or less measure from the five race-types.

ELECTRICAL NOTES.

It is not too much to say that without the various methods of electrical control that have been devised and which are in general use, it would be utterly impossible for the great railways of the world to carry one-half the traffic that they are now handling daily with safety and despatch. In this branch of electrical work steady progress is being made, and apart from the question of haulage, the extension of the methods of electrical control will probably be considerable in the immediate future.

The new electric railroad which has been constructed not long since between the towns of Kobé and Osaka is the first of the electric roads of Japan which connects two points already in communication by railroad. The electric line has a total length of 20 miles. There are some 30 stations upon this line. As to rolling stock, we find at present eighteen motor cars of Japanese build. The cars contain thirty places each, and are run at intervals of 12 minutes. The Kobé Osaka road is divided into four zones, and the tariff for the passage within a given zone is fixed at $0.025. Each zone is subdivided into two parts, and the rate for each part is $0.015. The rate for the total distance of the line is $0.10. As to the steam railroad between these two points, which has been running for some years past, it is owned by the Japanese government. There are but three stations between the two towns and one train per hour is run. The price for the whole distance is $0.17 in third class and $0.48 in second class. As to speed, the electric line is much superior, seeing that it covers the distance in one-half the time.

The chief factor in determining the policy of a road as regards electrification is that of economy. Any increase in the value of property which does not affect the railway directly and immediately will not enter into the problem. Where future profits are relied upon to make electrification pay, the change will not be made, as it is a generally accepted fact that a railroad must pay from the beginning, or else go into the hands of receivers. In other words, those who first control the property after the change must be shown that an immediate profit will result by the change. After some of the railroads have proved that electrical engineers' claims of economy are justified there will be a general changing over of roads where similar conditions exist, as soon as the work can be done. An appreciation of what this condition will mean can be obtained when we consider the present condition of the steam turbine. Steam turbines have been in use for about fifteen years, while it is only recently that the engineering world has been convinced of the economy attendant upon their use, and the other advantages, such as decrease in interest charges, less maintenance cost, ease of starting, and so on. Now that the engineering world has been convinced that the steam turbine is a good thing there is literally a rush for steam turbines, and the manufacturers find it almost impossible to keep up with the demand. A similar period of development in heavy electric traction work may be expected after two or three years' more experience.

Some information concerning the motor-equipped machine shop of the Pittsburg & Lake Erie Railroad at McKees Rocks may be of interest. The shops are compactly situated and consequently direct current can be used to advantage; the voltage in use is 250 For machine work, the multi-voltage system of drive is used and with excellent results. The voltages vary by steps of 40 from 40 to 240, with intermediate and additional steps obtained by means of field resistance. The controllers in use have 21 steps in forward motion, giving approximately 10 per cent increments. Individual motor drive was carried to a much greater extent than in any shop previously put up, but experience has not shown that any mistake was made in so doing. In the machine shop only one small group of tools is driven from shafting. All the others have individual motors. The tools in the group above referred to are such tools as drill grinders, polishers, bolt-threading machines, etc. In the wood-working shops, however, group driving is the rule; individual motors are used only on the larger machines; in general, in machines of this class, no change in speed is required and therefore group driving is entirely satisfactory. One excellent feature of the electric installation is the entire absence of exposed wiring, and yet every foot of the floor of the big machine and erecting shop, 172 x 530 feet, is accessible. This is accomplished by running a tunnel 3 feet 6 inches by 4 feet the full length of the shop, and from it branch ducts 4 x 12 inches from side-wall to side-wall every 5 feet 6 inches. These latter were made part of the floor, and were put in practically without expense. All the wiring in these ducts was put in after the floor was put down, loricated conduit being used.

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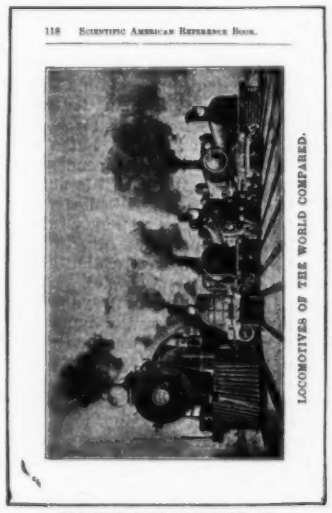
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